THE HAWAIIAN PLANTERS' MONTHLY

PUBLISHED FOR THE

HAWAIIAN SUGAR PLANTERS' ASSOCIATION

Vol. XXI] HONOLULU, DECEMBER 15, 1902. [No. 12

H. A. ISENBERG.
President of the Hawaiian Sugar Planters' Association 1902-3.

This number is given up exclusively to the reports read at the annual meeting of the Hawaiian Sugar Planters' Association, which was held in this city November 17 and 18. Vice-President H. A. Isenberg presided, in the absence of President W. G. Irwin. The reports are printed in full in this issue, excepting that of Mr. Eckart, on the "Work of the Experiment Station," covering one hundred pages, which was issued by him prior to the annual meeting. Copies of his report can be obtained from him, at the experiment station.

The officers of the association for the current year are—H. A. Isenberg, president; J. B. Atherton, vice-president; W. O. Smith, secretary and treasurer; Geo. H. Robertson, auditor; H. P. Baldwin, F. A. Schaefer, F. M. Swanzy, W. G. Irwin and B. F. Dillingham, directors.

This year's convention of Hawaiian planters was probably the largest that has been held, and the numerous reports presented have been more full and interesting in details than any heretofore made. Hawaii now occupies a very prominent position in the world's sugar industry, and the progress made here is keenly watched by those engaged in it abroad.

One cannot peruse the very interesting reports and replies given in this volume, without becoming convinced by the efforts made in each sugar mill to produce the best quality and largest quantity of sugar that it is possible to secure, under the various conditions in which they have been made. It is not claiming too much to say that our planters stand in the front rank of operators in this industry which is doing so much to promote the health and comfort of the human race. The time may not be far distant when the whole process of producing sugar—from the mill to the refinery will be done under one roof, and by methods as yet not yet fully developed.

Referring to the New York market, Czarnkow's report says: The supplies of cane sugars will be light until the middle of January, when considerable receipts of the Cuban and other West India crops may be expected. In these circumstances, we should have hardening prices for raws for at least the balance of the year. The favorable influences may, however, be counteracted by the demoralized condition, which has been brought about in the refined market through this week's cutting of prices. These cuts have more than swept away all margin of profit in refining and, so far from causing increased buying by the trade, have checked demand, through arousing a fear that further cuts are imminent. As any check in the demand for refined must affect meltings, the result of the demoralized state of the refined market is, for the time being, unfavorable to raws.

TWENTY-SECOND ANNUAL MEETING OF THE HAWAIIAN SUGAR PLANTERS' ASSOCIATION.

The annual meeting of this association was held on Monday and Tuesday, the 17th and 18th instant in the Castle & Cooke Hall on King street. The attendance was large, there being representatives from each island of the group.

In the absence of the president, W. G. Irwin, Mr. H. A. Isenberg, vice president, opened the session with the following address:

"To the Members of the Hawaiian Sugar Planters' Association.

"Gentlemen:—In welcoming you to the twenty-second annual meeting of our Association, I express my regrets at the absence of the President, Mr. Wm. G. Irwin.

"The past year has been one of unusual anxiety and depression on account of the low price of sugar, but it seems to me that the worst has been overcome and with an improving sugar market the general aspect for the future can confidently be said to be a bright one.

"The world's production of sugar has so greatly increased that the governments of the various sugar-growing countries in Europe have come to an understanding, by the Brussels Convention, in order to restrict the over-production of sugar beets and to abolish all export bounties on refined sugar. This convention will go into effect on September 1st next year, and it is expected that the same will be of decided benefit to all sugar producers on account of the anticipated rise in the price of sugar.

"With the increased production of sugar, competition has become so keen as to show more plainly the necessity of vigilance and the application of the best scientific knowledge in the manufacture of sugar. Had it not been for the improvements made in past years on our plantations I believe it would have been impossible for most of them to bear the unprecedented depression in prices which have recently prevailed.

"In considering the future of our sugar industry the two most important subjects, in my estimation are, first, mechanical and engineering features, by which economies in the cost of production can be made, and, second, the subject of labor, which principally has occupied the time of your trustees in the many meetings held during the past year, and, I suppose will also again be the foremost subject of consideration during this meeting.

"It is of the utmost importance that those who are carrying on the sugar industry of these Islands should confer together with a view of seeking to solve the differences which confront them. It is to be expected that men of thoughtfulness and of strong convictions will differ in matters of detail and even in matters of policy, but at the same time these men will not forget the proverb: "In Union There Is Strength;" also that under the prevailing circumstances co-operation is essential and absolutely necessary.

"Your trustees have had several interviews and also social intercourse with the members of the Senatorial Commission which visited these Islands on a tour of investigation. A memorial was read and presented to the Commission, setting forth the complete change in conditions since annexation took place and the needs of the Hawaiian Planters to meet these changes; also strongly urging some special legislation by Congress for restricted immigration of Chinese Agricultural laborers. It is to be hoped that this memorial will have the desired result, which would not only benefit those directly interested in sugar, but, in consequence, would have a good effect on the prosperity and welfare of the entire Territory.

"In conclusion, I beg to say that reports of committees on various subjects will be submitted for your consideration as usual, and I hope that the expression of your views will lead to harmonious understanding and will be of lasting benefit."

SECRETARY'S ANNUAL REPORT.

November 17, 1902.

At the annual meeting held in November, 1901, the following named gentlemen were elected Trustees of the Hawaiian Sugar Planters' Association for the year:

J. B. Atherton, F. A. Schaefer, H. P. Baldwin, W. G. Irwin, F. M. Swanzy, G. H. Robertson, H. A. Isenberg, B. F. Dillingham and W. O. Smith.

The Trustees so elected organized and chose the following named officers:

President .... W. G. Irwin.
Vice-President .... H. A. Isenberg.
Secretary and Treasurer............. W. O. Smith.
Auditor .... G. H. Robertson.

Forty meetings of the Trustees have been held during the year, besides many conferences.

The Committee on Labor, consisting of W. M. Giffard, J. P. Cooke, and W. Pfotenhauer have been most diligent during the year, and have rendered valuable service.

The principal matters receiving attention of the Trustees have been those relating to labor, adjustment to the new conditions resulting from the extension of Federal laws, proposed tariff changes, dealing with insect pests and blights and kindred subjects.

A joint meeting of the Trustees and delegates from the various plantations was held in March. A similar meeting was planned for June, but was postponed to meet in conjunction with the annual meeting of the association.

These joint meetings tend to establish a better understanding among the planters and a more uniform grading of wages for the different classes of work on the plantations.

Crops.—The crops harvested for the year ending September 30, 1902, have yielded well considering the great damage done by the drought of last year. The total output was 355,611 tons, being about 4,500 tons less than for the previous year. A tabulated statement of yields on the several plantations is presented herewith.

Experiment Station.—This Station has been operated during the year, and has maintained its high standard of usefulness.

In November, 1901, Prof. C. F. Eckart succeeded Mr. Blouin as Director of the Station, and the work at the station has been efficiently and satisfactorily conducted.

Members of the Association and Delegates will be interested in visiting and inspecting the gardens and operations.

Prof. R. L. C. Perkins has, in the absence of Prof. Koebele, rendered valuable service in the line of scientific research, and guarding against the introduction of pernicious pests and blights.

Planters' Monthly.—The publication of this magazine has been maintained, and, under the editorship of Hon. H. M. Whitney, has from time to time presented original articles, and extracts from other journals, of an instructive character. It is much to be desired that contributions be furnished by planters, giving the results of their work and experienes in various branches of their work. In seeking to attain the best results much may be learned from the experience and experiments of others.

With increased production of sugar, in the various sugar producing countries, and greater competition, it is imperative that the closest attention be given to economy in every detail of production and manufacture.

With the great variety of locality, climate and conditions which exist in the various parts of these Islands where sugar is produced, statements of results with different varieties of cane, methods of cultivation, fertilization, transportation and manufacture are instructive and profitable.

With all the problems that confront the planters, and tax their time and strength it is not a light task to prepare papers for publication; but such articles written by practical men are of the highest value.

In competing with other sugar producing countries, and the low prices of sugar which prevail, it is of the first importance that the best results be obtained.

In striving for this end and the value of the knowledge of the experiences and work of others is inestimable. The reports of committees are important, but in addition to these papers contributed to the Planters' Monthly, even if brief, are very much to be desired.

VISIT OF SENATE COMMITTEE.—During the recent visit of the Committee from the United States Senate the Trustees of the Association presented papers and statements upon various subjects relating to the sugar interests, and the general agricultural industries of the Islands.

Statistics and data as to average cost of producing sugar, production per acre, cost of transportation, and upon kindred subjects were furnished, and corrections were made of mis-statements and incorrect information which had been given.

REPRESENTATIVE AT WASHINGTON.—William Haywood, Esq., has continued as representative of the Association at Washington, and has rendered good service. His visit to Honolulu on the occasion of the meeting here of the Senate Committee was opportune.

CONCLUSION.—In union is strength, and at no time in the history of the sugar industry of these Islands has it been more important that there be interchange of views and co-operation.

The interests of these Islands—industrial, political and social, depend so largely upon the sugar industry, and the character and attitude of the sugar planters, the issues involved will doubtless be met in the same broad and dignified spirit which has heretofore characterized the deliberations of this Association.

WILLIAM O. SMITH,
Secretary.

REPORT OF COMMITTEE ON CULTIVATION.

TO THE PRESIDENT AND MEMBERS OF THE HAWAIIAN SUGAR PLANTERS' ASSOCIATION.

GENTLEMEN:—As with all other branches of our sugar industry in Hawaii the cultivation of cane has undergone many changes. New varieties of cane have been introduced and experimented with on every Island; the treatment of soils by scientific and practical experiments; the adoption of modern implements in our fields for plowing and cultivating; and the co-operation of planters through your association and experiment station have all been important factors in the development of cane growing in these Islands.

BREAKING AND PLOWING.—The methods of breaking-up or tilling the soil for seed-bed are varied, depending on locality and depth of soil. On Oahu, Maui and Kauai steam-plows are chiefly used, but only a few sets on Hawaii, as that island has only a limited area of land adapted for steam plowing. The capacity of steam-plows ranges from 10 to 15-acres per day plowing a depth of 1 to 2 feet according to requirements. In districts with light soils where animals are used for plowing the old style of hand-plow is fast being replaced by the latest design of "Sulky" and "Disc" plows. In the Hilo district most of the round plowing was formerly done by light wheel walking plows drawn by 3 animals, cutting a furrow of from 12 to 16 inches about 9 inches deep, and plowing about 1½ acre a day. The "Disc" plow has now become the favorite, and a number of planters use its exclusively, claiming better results from the more complete pulverizing of the soil, and especially from its adaptability to throw any extra depth of furrow or subsoil directly on the surface with increase of exposure to atmospheric influences. Several designs of harrow are now in use for the tilth of our soils before furrowing, but the Spike or Drag Harrow is more generally used than any other.

FURROWING.—The land is furrowed on an average about 5 feet apart, and depth of furrow depends on amount of surface soil or vegetable mould. Some furrow-plows are entirely too heavy and clumsy, and could be greatly reduced and improved. The handles of the ordinary furrow-plow are too high and too short. A change in a furrow-plow came under our notice this year that had been reduced in weight 190 lbs., the handles made longer, and, instead of fastening them on end of beam, were lowered by placing them in the body of the plow, and so giving to the operator more purchase over the plow. There is just as much economy in saving manual labor and mule-power in the fields as steam in the mill.

Various implements are in use to loosen up the seed-bed after the furrow-plow, viz:—Sub-soiler, small-plow, small-harrow, or cultivator. The Hilo Sugar Co. use 2 sections of a stubble-digger to revolve in the bottom of the furrow, fitted on a small frame with handles, and drawn by 1 animal, the implement stirring up the bottom of furrow to a depth of 6 inches. At Onomea there is another device for this work: 2 small subsoiler discs of about 14 inches diameter are attached face inwards to a small subsoiler and drawn after the furrow-plows, thereby widening the furrow and leaving an excellent bed for seed-cane.

PLANTING.—The general method of planting is to place the seed in the furrow by hand, butt to butt, and covered to a depth of from 2 to 3 inches. Many amusing notions still hold sway in the planting season. Some prefer top of seed left uncovered to keep the seed alive; others demand the seed-planted whichever way the wind mostly blows. In Hamakua this year a Japanese company threw up a co-operative contract on the ground that the seed was not planted so that it would grow the prevailing way of the wind. Suffice it to say that the young plant from this doomed seed is as far advanced today as the plant from seed of supposedly more favored conditions.

VARIETIES OF CANE.—Where plenty of water could be obtained, or the rainfall is abundant, the "Lahaina" variety of cane has proved the best; but in districts where droughts have been prevalent the "Rose Bamboo" variety has thus far stood the test. There is another variety named "Yellow Caledonia" that is now being spread extensively over the Islands to take the place of the other varieties—especially the "Lahaina" that in recent years has become deteriorated in older lands. From this variety, "Yellow Caledonia," some of the older plantations in the Hilo district are yielding from 6 to 7 tons of sugar per acre from old lands whereon it had become impossible to grow the Lahaina variety. Also on Naalehu "Yellow Caledonia" has been grown by Mr. Hewitt for several years, and has been proved a good cane for dry districts. Again, on Paauhau, a 40-acres section of Yellow Caledonia stood throughout the Hamakua drought of last year with scarcely a stick damaged, while at least two-thirds of the Rose Bamboo alongside died out. Both varieties were of the same age and had exactly the same treatment in every respect. Several other varieties are being planted and experimented with; but with the exception of the "Whitney" or Yellow Bamboo on Pahala (Kau),—which has been the standard cane on that plantation for many years—as also a White Bamboo grown on the same plantation, we know of no other varieties that are past the experimental stage.

The question of cultivation by animals between the cane rows is still much discussed. We firmly believe that wherever it is practicable cultivation between the rows should be done with cultivators drawn by mule power. A man and a mule with a cultivator or small plow can perform as much work as 10-men with hoes. It seems, therefore, fair to assume that this matter of detail should have careful attention, and especially at a time like the present when labor is very scarce, and the market for sugar ruling low. On nearly all un-irrigated plantations the land is freely stirred up and weeds controlled between the young cane rows; by mule power the exceptions are on those plantations where stony ridges and other conditions make it unpracticable to place animals in the young crop. Some planters still contend that using small plows in young plant is detrimental because they cut off too many young roots. But in rainy districts, where cultivation with small plows has been adopted for many years, it is now generally conceded that mule cultivation is most beneficial to young cane in that it thoroughly loosens up the soil for the cane roots to spread in, and improves the condition of the soil by frequent exposure to sun and atmosphere. A small plow of about 8 inches cut, and drawn by one animal, is considered the best size for cultivation in young cane.

In addition to the ordinary cultivator and V shaped harrow there is the "Horner" cultivator, now much in use, and especially in the Hilo district where weeds grow in the night. The principle of this cultivator is different to that of the ordinary implements. According to the quantity of weeds to be handled it drags them into piles about 20 or 30 feet apart thereby concentrating the weeds over a much smaller area than it left scattered over the entire row as happens with the ordinary cultivator. We might make mention of another labor saving implement, and for the purpose of this report we will call it the "Hiller." This is a device for throwing earth to the young cane. It is shaped like a snow-plow, and makes an excellent finish to a field of young cane when the growth is such as to about cover the rows. Mr. Albert Horner, (Kukaiau), has been experimenting this year with a new implement for hilling rattoons. It consists of two 16-inch discs placed on either side of a goose-necked beam, and with a subsoiler attached behind to loosen the narrow rim left by the discs in centre of row. The implement is drawn by 3 animals, and operated by one-man. This season Mr. Horner has hilled up all his rattoons with this implements, and we can certify that it makes far superior work to the ordinary method with hand-plow and harrow. The soil is thrown up to the cane in a finely pulverized condition; and also there is a saving of labor in that one turn of the implement in each row completes the operation.

STRIPPING.—The removing of dead leaves from the cane, generally called "stripping," is a process in our cultivation that is very essential in some sections of the Islands; and we think necessary in more or less degree in all districts for the proper development of a cane crop. Where the crop is not exposed to drought for a long period the best results are usually obtained from cane stripped some months prior to harvesting. Stripping also reduces the amount of destruction caused by borers, rats, and other pests; lessens the cost of cutting, and allows of sending cane to the mill free from a coating of dry leaves, the which is very much against good extraction. But with all our advancement in cultivation, we yet think that our present system might be improved. In recent years the scientific methods adopted in our processes of manufacture and fertilization have afforded keen interest and competition among all concerned, and to those methods chiefly, and their natural incentives, we largely attribute the high standard of Hawaii's sugar industry at this day.

The cultivation of crops directly calls for a large percentage of expenditure; and in view of the many difficulties to hinder planters from making observations abroad we would suggest for your consideration the securing of a competent man to collect data from the various plantations, and have same published in some form that would be of general benefit to all engaged in the production of sugar. In suchwise we would obtain much information regarding the different modes of cultivation, new varieties of seed cane, new implements, the results of various experiments, and other matter that would be of great value to each and all interested in the sugar industry of these Islands.

Respectfully submitted,

JAS. GIBB, Chairman.

REPORT ON MANUFACTURE.

HONOLULU, NOVEMBER 17TH, 1902.

MR. WM. G. IRWIN, PRESIDENT HAWAIIAN SUGAR ASSOCIATION.

SIR.—In order to obtain information on the processes in use in sugar mills, your Committee on Manufacture sent to each of the 55 managers of mills and plantations, a list of questions intended to bring out facts as to changes in methods made during the past year that have resulted in increased quantity and better quality of sugar, reduced cost of manufacture and decreased losses in the waste products.

We hoped to make up a table showing the results of the different process in use but the amount of information at hand is not sufficient for the purpose.

Replies have been received from 12 of the 55 managers and an abstract of their answers has been prepared to accompany their report.

Chemical control in mills is the exception rather than the rule and for that and other reasons, some managers have no doubt felt that they could not contribute exact information. They would not write what might be inaccurate and misleading.

Other managers have attached too much importance to the fact that the mills under their charge are not "Modern Mills," forgetting that although some of the so-called "Modern Mills" are of greater capacity, have crystallizers instead of coolers and water driven centrifugals instead of belt driven, they differ in no material respect from the good mills of earlier date, managed and worked by progressive men.

The results of the work in the smaller mills,—could exact figures be obtained,—would be found to be highly creditable to the efficiency of the machinery and to the men in charge.

Your committee find that a majority of the managers are in favor of the adoption of uniform methods of laboratory work.

A letter from Mr. J. N. S. Williams on this point is attached to this report.

We understand that a number of the chemists employed in the Territory have formed an Association. We would suggest that in carrying out the plan outlined in Mr. Williams' letter, the chemists be asked to consider the matter and to propose the rules for uniform practice. Men who are familiar with manufacturing in other places and with the economies necessary where there is close competition, are struck with the fact that we are far behind other manufacturers in the utilization of waste or by-products.

No other industry could stand the loss of 15 per cent of the raw product in the process of manufacture.

Our waste or by-products are the bagasse, scum press cake containing fibre and sugar, refuse molasses containing sugar in large quantities and probably other useful substances, and the ashes containing potash.

It is probable that the loss of sucrose in all the mills in the Territory will average 15 per cent of all the sucrose in the cane.

In producing a crop of 400,000 tons of marketable sugar of an average polarization of 96 per cent, approximately 65,000 tons of sugar are lost in the bagasse, scum press mud, molasses and undetermined losses. 65,000 tons of sugar at $50 per ton net worth the enormous sum of $3,350,000.00.

In bagasse, estimated	6.5%	value	$1,451,666.66
In press cake, estimated	1.0%	value	223,333.33
In molasses, estimated	5.0%	value	1,116,666.66
In undetermined, estimated	2.5%	value	558,333.33
	15.0%	value	$3,350,000.00

It may be argued that the bagasse is not a waste and that it is necessary for fuel to develop power for grinding and for steam for boiling. The sugar lost in the bagasse alone, however, as shown above, amounts to $1,451,666.66 or the price of 181,458 tons of coal at $8.00 per ton.

It has been proved that slow grinding and high dilution will add materially to the amount of sugar extracted from the cane by the mills and that by the use of machinery of good design and proper size worked continuously and to its full capacity, very thin juices may be taken care of without expense for extra fuel.

It may be found that a large part of the sugar lost in the bagasse can be saved by extremely high dilution as in some of the mills of the Colonial Sugar Refining Co. with a slight additional expense for other fuel.

The loss of sucrose in the molasses may be partly offset by its use as fuel but it is probable that other more profitable ways will be found and adopted.

Undetermined losses are probably exaggerated but they are so stated in all mill reports and cannot be ignored.

There are no doubt errors in weighing cane and measuring juices that account for some of the undetermined losses.

We would suggest that the utilization of waste molasses be made a subject for special investigation by a committee to report at the next annual meeting.

Respectfully submitted,

WM. W. GOODALE, Chairman;
F. B. MCSTOCKER,
E. K. BULL,
JAS. RENTON,
C. C. KENNEDY,
Committee on Manufacture.

PUUNENE, MAUI, OCTOBER 27TH, 1902.

HON. H. P. BALDWIN,
General Manager Hawaiian Commercial & Sugar Co.,
Puunene, Maui.

DEAR SIR:—In replying to the 11th question on the circular from the "Committee on Manufacture," I would say that a uniform system of chemical control and statement of results from our sugar houses is most desirable.

It is to be feared that individual rivalry has caused the natural demand for high results to be met in a way that does not conduce to further progress in certain branches of sugar manufacture, and I think it is certain that a well thought out system of sugar house control backed by a uniform method of arriving at results would in a short time produce handsome returns for the time and trouble expended.

I would take the liberty of suggesting that a special research committee be appointed for the purpose of looking into and reporting upon this matter; and since all practical branches of the business are interested, let the managers, engineers, sugar boilers and chemists be represented in the committee, say one from each branch.

Yours very truly,

J. N. S. WILLIAMS.

1st. Changes in setting and speed of mills, if any, and improvement in extraction resulting from such changes.

We did not make any changes in setting and speed of mills, but intend to do so next session. The large crop we ground wore off our rollers pretty badly, and a poor extraction at the end of the season was the result. (Oahu Sugar Co.)

Last mill run slower than first two mills, thus giving a heavier feed to the last mill, maceration behind second mill being increased at same time. (Kahuku Plantation.)

Set closer, and make better work; no change in speed of mills. (Paauhau Sugar Plantation Co.)

No change. Thin, quick feed is the best. (Waiakea Mill Co.)

We use different speeds for different canes. Speed of mills may be too fast or too slow for perfect extraction and should be controlled according to circumstances. (Makee Sugar Co.)

Surface speed of rolls—1st mill 16.2 ft. per min. 2nd mill 17 ft. per min. 3rd mill 18.7 ft. per min. Mill setting, 1st mill rolls open 1 in. and 3-16 in.; 2nd mill 3-8 in. and 1-32 in.; 3rd mill 1-4 in. and metal to metal. (McBryde Sugar Co.)

During the first four months of the grinding season of 1902, with running third set of rolls an average of 25 ft. per minute, and with a dilution by maceration of 13½%, the average extraction obtained was 92.55%

During the last four months of the season, using two nine-roller mills, the third sets of which were running an average of 18 feet per minute, and with a dilution by maceration of 32%, the average extraction obtained was 95.34%.

The highest extraction recorded here was with a speed of 15.57 feet per minute and a dilution of 50%. Extraction was 96.5%.

The difference between the extraction in the first two instances is 2.79%. Of this gain about one-half is due to the reduction in speed; the remainder to a heavy maceration and the method of applying it.

From daily statistics of speed and extraction extending over four months at the new Ewa mill, of which tests the above is a summary, it was conclusively proven that the closest setting and the slowest running mills give the best results. (Ewa Plantation Co.)

The Makaweli mill being the diffusion process, no questions relating purely to milling can be answered here. (Makaweli Plantation Co.)

During the first half of the grinding season the mills were run at high speed and owing to insufficient capacity of quadruple effect a very small quantity of water could be used for dilution.

Average extraction 90.46%, dilution 7.1%.

During the latter half of the season the mills were run at low speed, and more water used for dilution.

Average extraction 93.92%, dilution 20.4%.

Highest reported extraction 95.9% with 37.5% dilution. (Waialua Agricultural Co., Ltd.)

2nd. Improved methods of maceration and gain in extraction thereby.

The last month we installed a set of sprays in the maceration pipe, throwing the water at an angle of about 45° with the horizontal in the partly extracted cane, admixing much better with it and giving the same extraction with about two-thirds of the former amount of maceration water. (Oahu Sugar Co.)

The usual method has been followed, i. e., spraying water on trash after 1st and 2nd mills. (Olaa Sugar Co.)

By use of a spray cock, patented in Holland on the principal of an atomizer. Better work with same quantity of water. (Waiakea Mill Co.)

We are arranging to macerate with water only between 2nd and 3rd mills, and return the results of 3rd mill to the crushed canes before passing through the 2nd mill, believing the practice to be supported by good theory as well as practical results where properly tried. (Makee Sugar Co.)

Maceration after first mill with hot and very dilute milk of lime, strength of which varies according to quality of juice. After second mill hot water as usual. Average extraction January-May, 1901, 93.76%. Improvement is not in extraction but in other directions. (McBryde Sugar Co.)

In the matter of maceration the main improvement at this place has been made by increasing the volume of water of maceration, and by applying it all between the 2nd and 3rd sets of rollers, and pumping back the very dilute juice extracted by the third mill for macerating trash between the 1st and 2nd mills. It has been found by Mr. C. J. Penny, Chemist of Ewa Mill, that with approximately 32% dilution the gain by the above method in extraction over any other method is one half of one per cent. (Ewa Plantation Co.)

We macerate in both mills, to the extent of from 15% to 20%. In a test without macerating the extraction was 89.25%, with the above maceration our average for the last year's crop was 93.20%. (Paia Plantation Co.)

Best results from a given quantity of water were obtained by macerating with water after the 2nd mill and pumping the diluted juice from the 3rd mill back onto the bagasse from 1st mill. (Waialua Agricultural Co., Ltd.)

3rd. Improved methods of clarification.

We are thoroughly satisfied with our present method of clarification, and do not expect to make any changes for the present. (Oahu Sugar Co.)

No change. Clarification in open clarifiers and settling tank of Deming type. Juice limed cold before passing through heater. (Paauhau Sugar Plantation Co.)

Always carrying juice at exact neutral point. (Olaa Sugar Co.)

This mill started up using the Deming system of superheat clarification and continuous settlers, juice temperature carried at 240° Fahrenheit. In August, 1902, the high heat was abandoned and the absorbers of the Deming apparatus removed, heat carried at from 208°-212° Fahrenheit as a maximum, continuous settlers still used, but will be abandoned in favor of small intermittent settlers for next crop. Results improved all round. (Hawaiian Commercial & Sugar Co.)

We do not believe in hard and fast rules for clarification, where juices differ even on the same plantation; but we find superheating and automatic settling very satisfactory and efficient when properly worked and the juice properly limed. (Makee Sugar Co.)

Liming at mills as above and (with low quality juice) subsequent sulphuring. Improvement is in better control of tempering, and in cleanliness, and in saving time. The juice stands in clarifiers (after being brought to proper temperature) five to fifteen minutes, after which it is drawn off direct to the evaporators (McBryde Sugar Co.)

The superheated juice from the Deming settling tanks is strained through brass wire cloth with No. 80 mesh, giving good results. (Honokaa Sugar Co.)

The Deming system of clarification with a large number of separate settling tanks is used at Ewa. (Ewa Plantation Co.)

Nothing new. Our Deming Superheater gives good results, but the benefit is not very marked. (Makaweli Plantation Co.)

We have the Deming Superheater and settle in open tanks. (Paia Plantation Co.)

Deming clarifier with individual settling tanks of 1,000 gallons capacity. Inlet pipe for hot juice from clarifier extending down to the bottom of settling tank. (Waialua Agricultural Co., Ltd.)

4th. Improved methods of filtration and the results.

Former answer applies to this question also. (Oahu Sugar Co.)

Using very little lime in mud juice, preferably none. (Olaa Sugar Co.)

Sand filters were installed at commencement of crop, they work well mechanically, but the good work in sand filters depends entirely on good work in the clarification. Coral sand is not satisfactory. (Hawaiian Commercial & Sugar Co.)

We continue to use the sand filters, as we have done for many years, and to run our settlings, washings, &c. through the Krood presses. We also use the sulphuring process when necessary. (Makee Sugar Co.)

(a) By sand filters or other systems for the mill juice. We run all our mill juice through the sand filters, sometimes twice, i. e., sometimes after coming from quadruple. Not often necessary. (Makee Sugar Co.)

The system of double filtration here in operation gave a sucrose content of 1-8 in the mud. (Honokaa Sugar Co.)

Sand filters are not used here, nor is double filtration practiced, Dilution of scums has, so far, been most convenient and practical. This has resulted in a filter press cake with but 2.8% sucrose content. (Ewa Plantation Co.)

With the diffusion, a filter is hardly necessary. (Makaweli Plantation.)

Centrifugal lining of No. 20 mesh as a strainer at the mill, and linings of a wider mesh and coarser texture, through which the juice passes immediately before entering the Deming liming tanks. (Honokaa Sugar Co.)

(b) By double filtration or other systems for skimmings and settlings. (Paauhau Sugar Plantation Co.)

Double Filtration of Filter Press Cake. We have carried this out for some 3 years here at Kukaiau, and in order to find out just what we were gaining by this method we engaged Mr. Hartman to make several tests; we copy below from his report in this connection:

Press Juice Average Brix 1.11% Sucrose 0.87% Purity 78%. "If you take the formula for the estimation of the obtainable sugar, which is used in Australia, for the determination of the value of juices.

"Pure obtainable Cane sugar=Sucr. —$\frac{1}{2}$ (Brix—Sucr.) You will find that of the 0.87% extracted that you actually recover 0.73%."

All the water necessary for re-melting the Press Cake is used on the mills. Generally speaking, there is not enough and has to be supplemented by the addition of other hot water, into the Receiving Tank, the addition of this extra water precludes any possibility of any water from second filtration going on the mills at too high a density, and thereby injuring the extraction, the average amount of maceration is about 15 to 20%. The sucrose content of the residual press cake runs from 0.5 to 1.5%.

We find that remelting press cake, double filtering and using this second filtration water, as maceration liquid, to be a decided saving all round. (Kukaiau Mill Co.)

We have no skimmings. Our settlings and washings can go through sand filters after coming from presses, or mixed with clear juice as desired. (Makee Sugar Co.)

Single filtration undiluted mud, hot water and steam washing of cake in press. (McBryde Sugar Co.)

Double filtration. (Honokaa Sugar Co.)

5th. Improved methods of manipulation of syrups and molasses in vacuum pans.

We work our syrups and molasses in the vacuum pans in connection with the crystallizers as before, but do not wash our sugars any more in the centrifugals with water as it affects the keeping quality of them. (Oahu Sugar Co.)

We found a saving in time by drawing in our sugars into vacuum pans, and building on with juice. Sugars from this polarizing from 96 to 97, also towards end of strikes drawing in charges of 1st molasses. Purity was reduced, of waste molasses about 10%. All 3rd sugars were remelted also, only one grade, "A," being shipped, averaging 96.55% at the market. Method used in 1901 crop. (Kukaiau Mill Co.)

First massecuite boiled very stiff in pan so that circulation is almost stopped, water content down to about 5%, a few minutes before striking the charge hot No. 1 molasses is drawn in for the purpose of thinning down the massecuite only, no attempt being made to build on the grain from the

No. 1 molasses. Results are improved recovery of dry sugar on weight of massecuites, and corresponding reduction in polarization of No. 1 molasses. (Hawaiian Commercial & Sugar Co.)

We grain our first goods and centrifugal immediately from pan. We sulphur most of our molasses, and re-boil as often as found economical, using crystallizers according to requirements of the products being handled. (Makee Sugar Co.)

Ordinary methods. (McBryde Sugar Co.)

Boiling straight grades is still the practice at the Ewa Mill. A larger pan capacity and pans with large outlets for stiff boiling have enabled the sugar boiler to produce a much better grade of sugar and less molasses this year than heretofore. The Kilby 10′ 6″ pans of 25 tons capacity have proved very efficient especially for 2nd grades. (Ewa Plantation Co.)

Nothing new. All our low grade sugars are drawn back into the No. 1 Pan and boiled with syrup making "A" sugar. The low grade sugars are drawn dry into the pan and mixed with the syrup but not remelted. (Makaweli Plantation Co.)

(a). Grades of sugar marketed and their polarization.

We shipped two grades of sugar to the states with average polarizations of 99°79 and 94°44 and remelted our third grade sugar. (Oahu Sugar Co.)

A 97°, B 94°. (Paauhau Sugar Plantation Co.)

One grade, polarization 96°61. (Olaa Sugar Co.)

A sugar, polarization average 1902 98.02.

B " " " 1902 94.25. (Waiakea Mill Co.)

For first half of crop 75% A sugar of 97% polarization; 25% B sugar of 95% polarization. For last half of crop 100% A sugar of from 96.5% —97% polarization. (Hawaiian Commercial & Sugar Co.)

We have heretofore made two grades of sugar "A" and "A. S." Hereafter we will have no "grades" save difference in polarization. (Makee Sugar Co.)

"A" 97.11, B 92.67; C 87.35. (McBryde Sugar Co.)

A 98.4; A. D. 97.5. (Hilo Sugar Co.)

A 96.20; B 94.06, first part of season AA 96.90. This is the sugar formerly marked B, but during the latter part of the season washed in centrifugals and dried in the Hersey Dryer. (Waialua Agricultural Co., Ltd.)

A =No. 1,	Polarization	97.31	75.51% of
AA =No. 2,	"	94.87	19.44% "
C =No. 3 & 4,	"	89.66	5.05% " (Honokaa Sugar Co.)

A 98.18; B 95.09. (Laupahoehoe Sugar Co.)

There are but two grades of sugar marketed namely: 1st and 2nd, with polarizations averaging for the season 97.30 and 96.12 respectively. (Ewa Plantation Co.)

"A" sugar only is marketed. Polarization here 97.5, polarization S. F. or N. Y. always higher. (Makaweli Plantation Co.)

97.8 of A sugar, polarization average 97.5%.

2.2% of B sugar, polarization average 95%. (Paia Plantation Co.)

In 1901 we carried out the method of shipping only one grade, and found as regards final exhaustion of waste molasses that it was an excellent system, besides enabling us to manufacture a larger quantity of sugar in a given time. We have described this method in your question sheet.

During the last season we went back to the old method of making 3 grades, and shipping them, the sugar while drying in the Centrifugals was also washed, with the result that we reached a Purity of our waste molasses of 40.2%, while the results from the method as described in 1901 were only 31.7% Purity of waste molasses, besides which there was a difference of 5 gallons of molasses more per ton of sugar, by boiling 3 grades, than by re-melting and seeding.

We have decided, at the mill, to revert back to re-handling of low grades, either by seeding, or re-melting. This is undoubtedly the best method, outside of crystallizers of manufacturing sugars.

Our own inclinations and experience are against the use of any water being applied to sugar while drying in the Centrifugals, and we have found the addition of water to have the effect of causing the sugars to ferment, etc., besides raising the purity of the molasses. (Kukaiau Mill Co.)

(b). Quantity and quality of waste molasses.

Our quality of waste molasses was smaller than former season owing to the shipping of a second grade sugar; the purity was a trifle higher on account of the much larger amount of sugar produced within the same period with the same centrifugal capacity. (Oahu Sugar Co.)

Sucrose 29. Purity 35. (Waiakea Mill Co.)

For season 1902=27.9 U. S. Gallons to 2000 lbs. sugar (97°). Purity 39.16—sucrose 36.06. Solids 91.95. We have gone as low as 24.40 U. S. Gallons, and as high as 31.18. (Makee Sugar Co.)

The quantity can only be estimated, as the molasses used for stable feed was not carefully measured. Estimate about 25 gallons to the ton. Quality=Sucrose 23.3, Brix 53.20, Purity 43.79. (Honokaa Sugar Co.)

There were 25½ gals. of waste molasses per ton of sugar, analysing Brix 87% Sucrose 34.8% and Purity 40%. (Ewa Plantation Co.)

23.3 gallons per ton of sugar. Brix 89.2, Sucrose 33.9, Purity 38.0. (Makaweli Plantation Co.)

The quantity is not kept, but on last season's crop it amounts to 5.75 sucrose extracted. (Paia Plantation Co.)

6th. Methods of using crystallizers.

Our crystallizers were used as of old with full satisfaction. (Oahu Sugar Co.)

Heating crystallizers to temperature massecuite before filling, then gradually cooling off. (Olaa Sugar Co.)

For first half of crop 3rd massecuite only treated in crystallizers; for latter part of crop 2nd massecuite only treated in crystallizers. 3rd massecuite being so low that they are run into storage tanks. During the latter half of crop all crystallizers dried goods are taken back into vacuum pans dry, all low grades from storage tanks being too sticky to draw into pan are remelted and worked in with straight syrup. Hawaiian Commercial & Sugar Co.)

We use the crystallizers only for molasses or low grades sugars. No 1st or juice sugars being run into crystallizers, and no juice being mixed or boiled in strikes going to the crystallizers. (Makee Sugar Co.)

For second grade only. First molasses kept down between 62 and 65% purity, grained in pan and boiled very stiff 92° to 95° Brix. Stirred in crystallizers till cool (5 or 6 days) and dried. Resulting molasses is under 40% purity. This is boiled for coolers. (McBryde Sugar Co.)

E. E. Hartmann, Chemist,—Report on crystallizers in motion.

The purity of the molasses as shown below is the apparent purity obtained by dividing the direct polarization of the molasses by their Brix.

A record was kept of every crystallizer filled. The averages given below consequently represent several hundred individual determinations. In order to determine how much sucrose crystallizes on to the grain in a given time, a sample of the massecuite from every pan was dried in a hand-centrifugal, and the purity of the molasses thus obtained ascertained.

I. INFLUENCE OF TIME IN CRYSTALLIZER.

(a). Average Purity of Massecuite 61.

Purity of Molasses.

Time in Crystallizer.	M. C. dried hot.	M. C. dried cold.	Difference.
50 to 100 hours	47.59	39.61	7.98
100 " 150 "	45.80	35.65	10.15
150 " 200 "	44.69	34.57	10.12
over 200 "	44.69	34.21	10.48

(b). Average Purity of Massecuite 75.

Purity of Molasses.

Time in Crystallizer.	M. C. dried hot.	M. C. dried cold.	Difference.
Under 20 hours	54.8	47.8	7.0
20 " 30 "	56.7	48.1	8.6
30 " 40 "	56.9	48.0	8.9
over 40 "	56.3	47.2	9.1

II. INFLUENCE OF TIME OF BOILING ON FINAL DENSITY.

Average Purity of Massecuite 61.

	Actual Brix.	Hours Boiling.
Under 94° Brix	93.08	8 hrs. 50 min.
94 to 95° "	94.63	9 " 54 "
95 " 96° "	95.49	10 " 8 "
over 96° "	96.50	10 " 49 "

III. INFLUENCE OF DENSITY OF MASSECUITE ON PURITY OF MOLASSES.

(a). Average Purity of Massecuite 75.

	Average Purity of Molasses.
Under 93° Brix	48.48
93 to 94° "	47.76
over 94° "	46.68

(b). Average Purity of Massecuite 61.

	Average Purity of Molasses.
Under 94° Brix	39.32
94 to 95° "	36.33
95 " 96° "	34.74
over 96° "	33.52

(Waialua Agricultural Co., Ltd.)

Sugars boiled to make three grades and cooled off in crystallizers. First two grades marketed. Third grade melted and re-boiled.

(a). First part of season before installing Hersey Dryer.
A 60.2% Polarization 96.30.
B 39.8% " 94.00.
Last part of season after installing Hersey Dryer.
A 60.00% Polarization 96.45.
AA 40.00% " 96.88.

(b) Average for the season 26. 5 U. S. Gallons per ton of sugar. 36.14 Brix. 29.98 Sucrose. 34.80 Purity.

Lowest reported during season—83.1 Brix, 24.8 Sucrose. 29.9 Purity. (Waialua Agricultural Company, Ltd.)

We have heretofore marketed our 1st sugars as "A" averaging 80% at about 98° and 2nd sugars as "A. S." averaging 20% at 94°. Hereafter we propose grading all our sugars according to polarization only. (Makee Sugar Co.)

1901, 31.7% Purity; 1902 40.2% Purity. (Kukaiau Mill Co.)

As to quantity of waste molasses it is not possible to give an exact figure, as crop is not yet over. Quality of waste minimum observed to date—32.5% Pol. 37% Purity, Figure for discharge 36% Pol. 40% Purity. (Hawaiian Commercial & Sugar Co.)

44.6 gallons (U. S.) per ton of sugar. First part of season (includes No. 2 molasses) 39.1 Purity. Last part of season (No. 4 only) 31.5 Purity. (McBryde Sugar Co.)

7th. Disposition of waste molasses, whether used for fuel or thrown away.

Our waste molasses were used as fertilizer, running away in the mill waste water to the low lands on the Peninsula. (Oahu Sugar Co.)

Early part of season used as fertilizer; latter part used as fuel. (Kahuku Plantation.)

Feed to stock and thrown away. (Paauhau Sugar Plantation Co.)

Thrown away. (Olaa Sugar Co.)

Thrown away by sprinkling on bagasse. (Waiakea Mill Co.)

The plantations do not care to use the molasses. We throw it away. (Kukaiau Mill Co.)

Waste molasses is burnt with bagasse in the furnaces. (Hawaiian Commercial & Sugar Co.)

Feed for stock, etc., and overplus run into the sea. Hereafter expect to use for fuel. (Makee Sugar Co.)

Mixed with mill effluent water and used in irrigation. (McBryde Sugar Co.)

A part for stable use as feed to the live stock, the remainder thrown away. (Honokaa Sugar Co.)

Feed for live stock. (Laupahoehoe Sugar Co.)

All of this waste molasses is used for fertilizer, being mixed in small quantities in the waters of irrigation. (Ewa Plantation Co.)

Diluted with irrigation water in irrigating cane. (Makaweli Sugar Co.)

Used for fertilizer and feeding stock. (Paia Plantation Co.)

First part of the season waste molasses was allowed to run out into ditch with water from the mill and used for irrigation. Last part of season it was burnt with the bagasse. (Waialua Agricultural Co., Ltd.)

8th. What method of burning molasses have you found most satisfactory?

We tried to burn the molasses, but as it choked the fires and superheater flues and made the megasse-spouts to the furnaces too sticky, we abandoned the trial. (Oahu Sugar Co.)

Molasses sprinkled on bagasse as it leaves last mill after the fashion of applying maceration water; molasses conveyed to sprinkler from a tank suspended above carrier; molasses absorbed before boilers are reached. (Kahuku Plantation.)

Feeding it in the bagasse as it leaves the last mill, in thin streams at a rate not to exceed 1000 gallons per hour when grinding 50 tons of cane in the same time; or approximately 1 lb. of molasses for every 2 lbs. of bagasse. (Hawaiian Commercial & Sugar Co.)

Burning in furnaces together with the bagasse, similarly to burning Crude Oil. (Makee Sugar Co.)

Sprinkled upon the bagasse from third mill just as it has passed through the rollers. The molasses is all absorbed by the bagasse and does not clog in trash carrier or shutes. It makes a hard clinker when burned in this way. Plans have been made for a special form of furnace that is in use in Fiji and Queensland, by which the full fuel value and fine ashes of high analysis are obtained.

ESTIMATES OF FUEL VALUE OF MOLASSES BY E. E. HARTMANN, CHEMIST W. A. CO.

Estimate of value of molasses ashes based on a crop of 20,000 tons of sugar. At the rate of 25 gallons molasses per ton of sugar the season's production of molasses would amount to 20,000×25=500,000 galls. @ 12 lbs.=3,000 tons.

These 3,000 tons would @ 12½% yield 375 tons of ashes. Value @ $38.25 per ton, $14,344. These ashes can only be obtained by burning the molasses separately in a furnace specially constructed for the purpose. A proportion of the Potash is carried away with the gases. If the fire is allowed to become too fierce this loss is said to be considerable. It can be reduced at the cost of some of the heat by checking the draft.

The $14,000 or whatever part of it is actually saved, represents only the fertilizing value of the ash, for which there is a ready market. In the above no account is taken of the fuel value of the molasses. This latter is variously estimated at from one-quarter to one-third of that or ordinary coal. On the former, the lower, basis the 3,000 tons of molasses would represent coal,—taken at $10 per ton—$7,500.

9th. Do you use drying machines for sugars?

We have no drying machines for our sugar, the keeping qualities of them are most satisfactory as long as they are not washed. (Oahu Sugar Co.)

No. (Paauhau Sugar Plantation Co.; Waiakea Mill Co.; Makee Sugar Co.; McBryde Sugar Co.; Honokaa Sugar Co.; Laupahoehoe Sugar Co.; Makaweli Plantation Co.)

No special machines for drying are used, but the sugars are scattered into a bagging bin, which tends to cool them. The first half of crop sugars were washed, now they are not. Our sugars keep very well, but no returns from late shipments have yet been made, so definite figures are not at hand. (Hawaiian Commercial & Sugar Co.)

1 quart of water for "A" sugar, 2 qts. for "B." Lower grades not washed. (McBryde Sugar Co.)

There are no dryers in use at present. Three are bought for use in the coming campaign. No water at all is used in the Centrifugals for No. 1 sugars. Water is used in centrifugaling 2nd grade at the rate of 1½ qts. per each 40 inch centrifugal. In marketing the sugar the loss in polarization of No. 1 has been almost nil. In No. 2 sugar the loss is greater. Up to date it has averaged 1%. This deterioration will be almost entirely eliminated by the coming dryers. (Ewa Plantation Co.)

About four weeks before the end of season a Hersey Sugar Dryer of 100 tons per day capacity was installed and used on the 2nd grade of sugar during the remainder of the season. The sugars were washed in the centrifugals and dried by hot air. The results were satisfactory on the whole, a set of sample bottles of sugars accompany this report showing the effect of washing and drying upon a sugar of low polarization.

Account sales of but one lot of dried sugar has been received. The New York polarization exceeded that made at the mill before shipment.

TEST OF HERSEY DRYER.

Two charges of 330 lbs. of Massecuite each were weighed out into two centrifugals, and dried simultaneously for ten minutes.

No. 1 charge was washed with 3 qts. of water, and subsequently dried.

No. 2 had no water, and was not dried.

	Brix.	Sucrose.	Purity.
Massecuite.	92.5	61.06	66.0

Products.

No. 1.	No. 2.
Sugar (Basis 3c.)	
134 lbs. of 97.9 Pol.	163 lbs. of 89.2 Pol
Value @ 3.0594c.=409.98c.	Value @ 1.9500c.=317.85c.
Molasses.	
202 lbs. Brix........86.7	167 lbs. of Brix........88.4
Sucrose 34.8	Sucrose 33.6
Purity 40.1	Purity 38.0
Estimated Yield of Molasses. (Purity of Waste Molasses assumed as 32).	
21.5 lbs. Sugar of 96 Pol.	13.5 lbs. Sugar of 96 Pol.
Value @ 3c.=64.50c.	Value @ 3c.=40.50c.
Total Yield.	
134 lbs.........409.96c.	163 lbs.........317.85c.
21.5 " .... 64.50c.	13.5 " .... 40.50c.
155.5 " ....474.46c.	176.5 " ....358.35c.

Saving in Freight on one ton of sugar—

To New York via New Orleans............	$1.70 per ton.
To New York via Cape Horn............	1.16 " "
To San Francisco	.62 " "
Averaging saving per ton of sugar..............	$1.16
2000 lbs. Sugar No. 2............................	$40.61
Its equivalent, or 1762 lbs. Sugar No. 1.........................	53.76
Difference in favor of washing and drying........	13.15
Average difference in freight, etc............	1.16
	$14.31

Cost of containers per ton of sugar remains unchanged. Of No. 1, one bag holds 111 lbs., of No. 2 125 lbs. Thus the saving made by reducing the weight of the product is neutralized by its greater volume.

Up to June 21st, 6080 tons B sugar of an average polarization of 94.0 were shipped from here.

Had the same amount of sucrose been shipped in the form of sugar of 97 polarization, a saving of $7,151 would have been made on the difference in the price and the saving in freight only.

(Basis 3c.)

I. 6080 tons 94.0 Pol. @ 2.500c.	$30,400
II. 5892 tons 97.0 Pol. @ 3.031c.	35,718
Difference in favor of II.	$ 5,318
Saving in freight on 6080—5892=188 tons @ $9.75 (average of last year)	1,833
	7,151

No account is taken in this of the better exhaustion of the molasses and the saving in boiling time.

Drying sugars before shipment results in sugars of higher polarization by exactly the amount of water removed. Sugars containing say 1% moisture may be increased in polarization nearly one degree, which in itself causes an increase in price. In the case of a sugar just below the turning point in quality, i. e., less than 96. 93. or 90. polarization, drying may easily put the sugar into the next higher class and sell for a much higher price. (Waialua Agricultural Co., Ltd.)

10th. Have you a system of chemical control in your mill?

Yes. (Oahu Sugar Co.; Kahuku Plantation; Olaa Sugar Co.; Hawaiian Commercial & Sugar Co.; Makee Sugar Co.; McBryde Sugar Co.; Makaweli Plantation Co.; Paia Plantation Co.)

No. (Paauhau Sugar Plantation Co.; Waiakea Mill Co.; Laupahoehoe Sugar Co.)

No chemist employed, but system of control is kept. (Kukaiau Mill Co.)

A partial one. (Honokaa Sugar Co.)

The Ewa Mill is under chemical control. I am heartily in favor of the adoption of a uniform system of chemical control for use in the sugar houses of this Territory. (Ewa Plantation Co.)

We have chemical control. (Waialua Agricultural Co., Ltd.)

11th. Are you in favor of adopting a uniform system of laboratory work, methods of calculating results and exchange of daily or weekly reports with other plantations?

We are in favor of a uniform system of laboratory work throughout. (Oahu Sugar Co.)

Yes. (Kahuku Plantation; Olaa Sugar Co.; McBryde Sugar Co.; Paia Plantation Co.)

Yes, strongly in favor. (Paauhau Plantation Co.)

Yes, we are in favor of one uniform method when practical, all round, and would like to know more about what others are doing. (Kukaiau Mill Co.)

Most decidedly, see special letter in regard to this. (Hawaiian Commercial & Sugar Co.)

Yes, as far as the benefits would prove reciprocal. (Makee Sugar Co.)

I have been for many years strongly in favor of uniformity in laboratory work and methods of calculating results, and suggest that a committee be appointed to further these ends; and I am also in favor of exchanging reports with other plantations. (Honokaa Sugar Co.)

No. (Waiakea Mill Co.)

Not at present. (Laupahoehoe Sugar Co.)

During the last season there has been a regular exchange of reports between a number of mills and the results have been decidedly beneficial. We believe that this should be encouraged. We are in favor of adopting a uniform system of laboratory work and methods of calculating results. We are in favor of an exchange of reports between mills having chemical control. (Waialua Agricultural Co., Ltd.)

REPORT ON MACHINERY.

To the President and Members of the Hawaiian Sugar Planters' Association.

Gentlemen:—Your committee have been unable to meet together for the purpose of framing a report as a committee, I therefore beg to submit the following as a personal report on machinery.

Since the last annual meeting of this Association, there have been at least, two large complete new sugar factories started operations, the one the property of the Olaa Sugar Company of Hawaii, and the other the Puunene Mills, of the Hawaiian Commercial & Sugar Co. of Maui. In addition to these there has been a complete reinstallation of new machinery at the Ewa Plantation Co.'s Mill on Oahu, and also the Maui Sugar Co.'s Mill on Maui.

It is naturally to these latest built mills that we look for the latest improvements in machinery. The long continued low price of sugar, and the high cost of labor, have not by any means, encouraged the introduction of new and improved machinery into the older mills of these Islands, though these hard conditions may in some way be credited with the introduction of machinery of a labor saving nature.

Let us now consider what has been done in this line:—Cane cutting in the field by other that the old method of hand

and cutlass, has been, and is still, occupying the attention of those interested, as will be seen from the experiments made with Mr. R. H. Pauls' invention, tests of which, are fully described in the Planters' Monthly of October, 1902 page 460. This is certainly a step in the right direction, very encouraging, and from which we may hope to be able in the near future, by the adoption of this, or some other such mechanical device, cut down our present high rate of cost for cane cutting.

In the matter of loading cars in the field by machinery, several tests have been made on Maui, but the hoisting machinery used there, was found to be too cumbersome and heavy, for easy transportation throughout the fields on Portable Track, and was therefore given up. The gross weight of this apparatus was about 20,000 pounds, however I am indebted to Mr. C. C. Kennedy of the Waiakea Mill Co. for the following information and figures in connection with the loading of cane in the field by mechanical means. This hoisting arrangement complete weighs but 4,000 pounds, is set up on an ordinary flat car, can work in any direction, and by its low weight is thereby made convenient in handling about the fields on Portable Tracks. The engine in connection with this crane, is worked by gasoline, thereby insuring lightness, saving in transportation of coal and water, and with little risk of fire. Actual results at Waiakea with the use of this loading apparatus show, that four men can take from sleds and load upon cars 200 tons of cane in eight hours, at a cost of $4.00 for labor, and from 75c. to $1.00 for the gasoline consumed doing this amount of work, hence we have, 200 tons of cane loaded for say $5 or 2½c. per ton. At this plantation sleds are used for getting cane to within reach of the hoist. A sling is placed on the sled, the cane loaded upon it. When the sled is run alongside the loading machine, it is a simple matter to hook into the sling, raise it to the desired position, above the car, pull a small cord releasing the cane from the sling, and out drops the 1,500 pounds of cane. This method works without a hitch. For comparative purposes to this cost must be added the cost of loading and hauling the sleds to the hoisting apparatus, which according to Mr. Kennedy is ½ cent per ton; therefore we now have 2½ cts.+12 cts.=14½ cts. the total cost per ton of packing and loading. It would be well for those interested to visit Waiakea and see this labor saving device at work.

Cane unloading at the carrier. For this some years ago an invention patented by W. C. Gregg was installed at the Ewa Mill, and with such excellent results that its adoption became very general throughout the mills of these Islands. This apparatus since its introduction at Ewa and elsewhere, was the only kind in use on these Islands, until the start of the Olaa Sugar Co.'s Mill, when the Bodley & Mallon cane unloader was introduced, with excellent results. Also one of the same make being installed at Waiakea the early part of this year. As we now have in the two latest built mills here, a Bodley & Mallon unloader at Olaa, and a Gregg unloader at Puunene, it might be interesting to make comparisons of merits, if any, of one over the other. I am indebted to Mr. J. N. S. Williams the mill superintendent at Puunene for the following: "I have to say in reply to cost of handling cane by Gregg's cane unloader, that the machine which consists of two sets of four triangles each, has given entire satisfaction during the past eight months' work, and has cost very little for repairs, and there have been no break downs during this period.

Maximum amount of cane handled by one machine per month was 30,000 tons, and the cost per ton in handling 2.52 cents, this includes taking the full cane cars from the storage tracks, weighs, discharges, cleans and reweighs the empty cars and places them on the storage tracks for empty cars.

Now with reference to the Bodley & Mallon unloader, Mr. H. Wicks of Olaa says, the cane unloader that was installed at our mill has worked most satisfactory during the season, requiring only two men to manipulate the two feeders, when worked from both sides of the carrier, it gives better results than any other feeder on the market. In writing on the saving of labor effected by the introduction of this apparatus to the Waiakea Mill, Mr. Kennedy says, this is one of the finest and easiest machines to work I have ever handled. A man can work it easily and feed as called for. I have never seen a machine do the satisfactory work of this one, it starts, stops, raises and lowers perfectly, and is built so strong that we had no difficulty whatever with it.

A passing remark touching upon some of the weak points of the vacuum pans lately installed in some of our new factories, may be of some service to those who intend purchasing new pans.

I would first call attention to the length of coil in proportion to its diameter, which in my opinion is too great to be advantageous, because the steam long before it reaches the end of coil is condensed and thereby retards the work of evaporation, or in other words reduces the heating surface by just that length of coil at the point where condensation takes place to such an extent that the area of the coil is practically full of water, another weak point in the style of the coil, is the fact of the steam having a return bend, and too little fall for the good drainage of coils. These are also placed too close together for two reasons: first, it is impossible to boil a heavy strike of massecuite without leaving a heavy body of sugar on the coils, and this especially at the lower end or bottom of pan. Second, it is found impractical to get at the coils for cleaning by other than chemical means. The coils are also, in my opinion placed too close to the walls of the pan body, especially at the conical bottom, to allow a free passage for the discharge of heavy massecuite. The circular perforated internal feed pipe was also an obstruction to the good discharge, but this I think was never allowed to be left in, in any of the pans installed at either Puunene or Olaa.

The discharge gates on these pans have also been found a great drawback, as there are times in all sugar factories, when by cutting a strike quite an item in the saving of labor and time can be effected, but with the swing gate, when once opened, it is next to impossible to close tightly, before the entire contents of the pan has to be discharged, where with the sliding gate little or no difficulty is met with in this operation.

The circulation in the Olaa pans, according to Mr. Wicks, is much retarded by the body of massecuite carried above the top coil to the height of the pans capacity, this difficulty however has been overcome by striking a smaller amount of massecuite than the capacity of the pan is built for.

One of the neatest and simplest labor saving devices I have yet seen, is the bagging bin elevator, etc., installed in the sugar room of the Puunene Mills; a brief description of which may be of interest.

The sugar from the centrifugals is dropped directly into a U shaped trough, this trough being long enough to take in the number of machines at work, and with the help of a screw conveyor is discharged on to a Robbins belt conveyor, the first I believe installed in this country. The latter consists of an endless rubber belt, and by the angular setting of little broad faced pulleys, takes a trough form, when running, and elevates the sugar to the bin, where it falls upon a rapidly revolving fan, which scatters and cools the sugar. From the bin the sugar is spouted to the bags, which are filled on the scales. One man doing regular work, bags and weighs from 90 to 100 bags of 125 pounds each per hour. The scattering and cooling of the sugar as it is thrown off the revolving fan has an excellent effect upon its keeping qualities, as will be seen from one lot of sugar that was in transit to New York some 75 days, where upon landing the test showed .7° polarization higher than the shipping test, showing thereby a drying out, and an increase in purity, to compensate for loss in weight.

By this installation they estimate a saving of 10 men in the sugar room.

As fuel oil has now been at work on the boilers of one of the pumping stations of the Kihei Plantation Co. since the early part of October, with some degree of success, where four Babcock & Wilcox boilers are installed, and as this fuel promises to be very generally adopted for like pumping stations and other work, for which coal is now being consumed, throughout these Islands, I have considered it will be of interest enough to add herewith, an average week's work with fuel oil, at this pumping station and compare with this a week's work on coal, doing the same duty. What effect, this new fuel is going to have upon the life of boiler tubes, remains to be seen.

For the seven days of twenty-four hours each, ending October 25th, we consumed 23,953 American gallons, this divided by 42 would give us 570.3 barrels and 570.3×$1.40 (cost per bbl. delivered) ....$ 798.40
Coal 19 tons per 24 hours @ say $9.00 per ton landed. 1197.00

Difference ....$ 398.60

$$\text{or } \frac{398.60 \times 100}{1197} = 33.3\% \text{ saving.}$$

The saving in labor so far effected by the introduction of fuel oil at Kihei, is a fraction over 30%, but this allowing the four boilers to be cleaned every two weeks, as against every four weeks with the use of coal.

Before entering upon the subject of extraction of sugar from the cane, I would like to say, it may be thought that my taking up the subject of extraction in the report on machinery is trespassing on the grounds of your committee on manufacture, but having discussed the subject with Mr. J. N. S. Williams, mill superintendent at Puunene, and to whom I am indebted for the following observations and data, and with whom I fully agree in his statement, that on the contrary, this subject is most distinctly a matter for the committee on machinery, seeing that the crushing apparatus and adjustments thereof are solely in the hands of the engineering department.

The subject of extraction is one of the first importance, as the loss of sugar going off in the cane refuse after extraction is, in a factory equipped with crushing machinery a large proportion of the total losses.

The methods for computing this especial loss are so various in different parts of the world, that a short review of these, may be of interest. A method said to be due to Dr. Maxwell, is, to take the polarization of the normal juice, and multiply by the actual juice content of cane, divide by 100, and then deduct from .1 to .3 the remainder being "Sugar in Cane." A method in use in Java said to be due to Prinsen Geerligs, is to take 85% of the polarization of the normal juice as the sugar content of the cane, from which said juice was extracted. A method in use in Australia, and stated to be due to Dr. Kottman, is to take the brix reading of the first mill juice, and divide by 100, to determine the pure sugar in the normal juice, sugar in cane then determined as usual. And there are doubtless many others.

If it could be determined with exactness what the normal juice is, the rest is easy, but it is as difficult to obtain the true normal juice as it is to obtain a true sample of cane.

The method of determining the sugar in the cane from the polarization of the normal juice, and using a variable factor for correction leaves room for doubt, as to the reliability of the factor. And in this connection I will quote from a letter received from a prominent plantation manager in April, 1900.

"To make my case as strong as possible I went data gathering, and was surprised and bewildered to find the different methods of arriving at 'Sucrose in Cane' and 'Extraction,' and I must confess, that I came home imbued with the idea that it only required the ability to be the last to hand in your extraction, to beat all prior comers, and that you could put up figures that no man could dispute, if you were clever enough."

Since that letter was written there has been no change in the methods adopted, and an examination of the figures that follow, will show what differences exist, even in factories at short distances from each other, and apparently grinding the same kind and quality of cane.

The following figures are taken from the annual reports of several first class factories in these Islands denoted in the following table by numbers:

No. 1.	1899.	1900.	1901.
Fibre in Cane	12	12	12 Estd.
Pure Sugar in Cane	16.76	16.18	14.95
Pol. Normal Juice	19.14	19.27	17.40
Extraction	97.25	97.14	96.72
Sugar left in Bagasse per 100 Cane.			

No. 2.	1899.	1900.	1901.
Fibre in Cane	11.37	11.80	11.57
Pure Sugar in Cane	14.76	14.29	13.83
Pol. Normal Juice	16.88	16.24	15.96
Extraction	93.29	92.16	91.25
Sugar left in Bagasse per 100 Cane	.99	1.12	1.21

No. 3.	1899.	1900.	1901.
Fibre in Cane	10.9	10.91	11.4
Pure Sugar in Cane	14.893	15.38	14.686
Pol. Normal Juice	17.47	17.75	16.98
Extraction	91.11	93.23	92.74
Sugar left in Bagasse per 100 Cane	1.324	1.04	1.07

No. 4.	1900.	1901.
Fibre in Cane	11.2	10.9
Pure Sugar in Cane	13.95	13.28
Pol. Normal Juice	15.70	15.50
Extraction	91.68	91.42
Sugar left in Bagasse per 100 Cane	1.16	1.14

No. 5.

	1899.	1900.	1901.
Fibre in Cane	11.63	12.17	11.85
Pure Sugar in Cane	16.01	16.30	14.86
Pol. Normal Juice	18.21	18.13	16.86
Extraction	91.44	92.79	93.20
Sugar left in Bagasse per 100 Cane.			

No. 6.

	1899.
Fibre in Cane	11.11
Pure Sugar in Cane	17.35
Pol. Normal Juice	20.54
Extraction	90.98
Sugar left in Bagasse per 100 Cane	1.57

No. 7.

	1899.
Fibre in Cane	11.2
Pure Sugar in Cane	12.28
Pol. Normal Juice	14.6
Extraction	87.8
Sugar left in Bagasse per 100 Cane.	

It will be noted that all of the foregoing factories state in positive terms the amount of pure sugar in the cane and also the polarization of the normal juice, and the following comparative table is compiled to show the difference in method of estimating sugar in cane used by different factories.

For comparative purposes I will assume that the sugar in the cane$=\frac{(100\text{-Fibre}) \text{ X Pol. Normal Juice.}}{100}$

		A Sugar in Cane per Report.	B Sugar in Cane per Formula.	Ratio A to B in %	Total Losses as Reported.
Factory No. 1	1899	11.76	16.73	100.18%*	Not Given
	1900	16.80	16 95	99.11	Not Given
	1901	14.95	15.31	97.65	Not Given
Factory No. 2	1899	14.76	14 783	99.85	16.14%
	1900	14 29	14.323	99.79	17.19
	1901	13.83	14.123	97.92	17.85
Factory No. 3	1899	14.893	15.565	95.7	16.90
	1900	15.38	15.813	97.27	13.91
	1901	14.686	15.044	97.62	18.92
Factory No. 4	1900	13.95	13.941	100.00	27.8
	1901	13.28	13.81	96.16	20.41
Factory No. 5	1899	16.01	16.092	99.5	15.83
	1900	16.30	15.923	102 3*	14.80
	1901	14.86	14.86	100.00	15.36
Factory No. 6	1899	17.35	18.258	95.0	Not Given
Factory No. 7	1901	12.28	12.965	94.72	Not Given

*Probably due to clerical errors.

In this table the amount deducted from the figure given by formula $\frac{(100\text{-Fibre}) \times \text{Pol. Normal Juice}}{100}$ can be found for each place and each crop by deducting the figure in column A from the figure in column B. It will be noticed that there are two instances where an addition has apparently been made, but this is most likely due to clerical or printers' errors.

This table shows plainly that not only do the different factories use a different correction for deduction from the figures given by the polarization of the normal juice, when computing the content of sugar in the cane, but the same factory uses a different correction for different crops or years.

Take for instance factory No. 2 for the year 1899, the correction was .023 as a deduction, for the year 1900 .033, and for the year 1901 the correction was .293, wherefore these differences, and why did not the same differences apply to factory No. 3, which is a next door neighbor, and grinds practically the same kind and quality of cane?

The corrections for factory No. 3 are for 1899, .672, 1900 .233 and for 1901 .358, some little light is thrown on this subject if one studies the total losses, and examining the figures for factory No. 4, it will be seen that in the year 1900 no correction was applied and the total losses footed up to 27.8%, while in the following year a correction of not less than .53 was applied, with the result that the losses were brought down to 20.41%.

It is usually very easy to pull things to pieces and create a loss of confidence in existing methods, and per contra. it is as a rule difficult to build up and induce confidence, but in this particular instance, the rule is reversed.

It is entirely unnecessary to go to the time and trouble to approximately determine the amount of sugar in the cane for the purpose of getting at the extraction of the pure sugar, because it is easy and at the same time correct, to take the sugar that comes into the house in the extracted juice, add to it the sugar going off in the bagasse in the furnaces, and the total is the sugar that was in the cane, that was crushed or otherwise treated. In a well conducted house there is no room for loss between the extracting apparatus and the liming tanks or clarifiers, and with proper system or weighing or measuring and sampling the juice, the amount of sugar coming into the house should be accurately known.

This is not the place for a discussion as to the methods employed in the analysis of bagasse, but I would draw attention to one point, which is, that the time during which the sample of trash is under treatment in the extraction apparatus for the direct determination of the sugar content has a considerable bearing on the result. For instance, supposing that one analyst subjects a sample of bagasse to treatment for three and one-half hours, and another for seven hours, now it is clearly to be seen, that it takes seven hours in one place, to completely exhaust a sample of bagasse of its sugar, a treatment, in another's hands of only three and one-half hours will not exhaust completely the sample and where the one may find 5% sugar in his trash, the other may find only 3% the final calculations from which results would show, a very material difference in extraction of sugar from cane in the two cases, although the sample of cane and bagasse may have been nearly alike.

It is found in the H. C. & S. Co. factory that the sugar in the bagasse, after passing the nine-roller mill with an ultimate pressure on the last set of rolls of 430 tons, and a dilution of about 18%, varies between 4.8 per cent and 5.4 per cent. And this when grinding cane at the rate of 50 tons per hour.

It is also found when running at this capacity, an increase up to 25 per cent in the dilution, does not make any difference in the extraction, and further research into the matter, shows us, that the sugar left in bagasse per 100 of cane, is almost in direct proportion to the fibre content of cane under operation.

A further observation is, that extraction rises and falls, as the polarization of the first mill juice rises and falls, and indeed this must of necessity be the case, when the sugar content of the bagasse remains, almost a constant figure, you will please note that all these observations, were made when grinding cane at the rate of about 50 tons per hour, which is practically the ultimate average capacity on ordinary cane of a 34″×78″—9 roller mill, with Krajewski attachment, and also that extractions are calculated in the usual way, by determining fibre in the cane, sugar and moisture in bagasse, sugar in normal juice, and calculating therefrom.

The foregoing observations extend over the manufacturing of some 24,000 tons of sugar. The samples from which the above deductions have been drawn are in very considerable number, and extend over some eight months of time, so they may be deemed as almost conclusive. What would result from slow running with light feed, still remains to be shown, but it is certainly very promising.

This brings us to the point of the extreme desirability of a common sense method of determining extraction, for it is difficult to imagine anything more exasperating for a conscientious engineer, who has got everything screwed up to the pitch of efficiency, to receive exceptional figures from some other place, without knowing how these figures were obtained.

Repectfully submitted,

JAMES SCOTT,

Chairman of Committee on Machinery.

FERTILIZATION.

TO THE PRESIDENT, TRUSTEES AND MEMBERS OF THE HAWAIIAN SUGAR PLANTERS' ASSOCIATION.

GENTLEMEN:—The committee appointed by the President to report on fertilization at this meeting of the Association were, C. F. Eckart, J. A. Scott, A. Lidgate, H. A. Baldwin and Wm. Pullar. Circular letters bearing on fertilization practices were addressed to all of the plantations of the islands, and through the willing co-operation of the managers, the committee is indebted for valuable data which will shortly be presented.

In intensive agriculture, such as is practiced on these Islands in the growing of sugar cane, the question of fertilization must needs be a very important one. Owing to the wide diversity of conditions with regard to climate and soil which characterize the sugar lands of this Territory, it becomes manifest that the subject of fertilization is one which must be worked out in large measure for each individual plantation. Not only must the needs of the crop be taken into consideration and weighed with relation to the quantity of plant foods stored up in the soil, but the forms in which the various fertilizing ingredients must be added to the soil to render the best service constitutes a subject of equal importance.

The financial loss which may accrue from the improper use of fertilizers does not merely include money expended on fertilizers which do not give increased yields of sugar per acre, but added to such amount is the cost of labor in applying such material to the soil. Again in the utilization of the waste products of the mill and stables, which would otherwise be discarded, the loss involved would be the resulting difference in yields following the rational and irrational application of such material. That fertilizers pay, and pay well, when judiciously applied has long been demonstrated on these Islands and much has been written on the subject and presented in former reports. In this report it is our desire to give an idea of the amounts and commercial value of fertilizers applied during the growth of a crop, and to indicate in a measure some of the ways in which a part of the money so expended might not be in the most full accordance with economy.

The data received from plantation managers have yielded the following approximate figures:

The amounts of purchased mixed fertilizer applied per acre varied from 400 to 1700 lbs.

The variation in the potash content of this material was from 4 to 21 per cent; phosphoric acid $3\frac{1}{2}$ to $15\frac{1}{2}$ per cent; nitrogen 4.1 to 9 per cent.

The average amount of mixed fertilizer applied was 850 lbs. per acre; and of nitrate of soda 159 lbs.

The crop of 1902 was harvested from approximately 79,000 acres.

The mixed fertilizer used for the crop approximated 33,575 tons.

The nitrate of soda used for the crop approximated 6,280 tons.

The average formula of the mixed fertilizer was 6% nitrogen, 8% phosphoric acid and 9% potash.

Nitrogen in mixed fertilizers applied	2,014	tons
Phos. Acid " " "	2,695	"
Potash " " "	3,290	"
Nitrogen in nitrate of soda	942	"

The value of these elements would be very much as follows:

Nitrogen in mixed fertilizer	$ 604,200
Phos. Acid " "	215,600
Potash " "	312,550
Total value of mixed fertilizer	$1,132,350
Nitrogen in nitrate of soda	282,600
	$1,414,950

In addition to the amount of mixed fertilizer and nitrate of soda applied, about 1500 tons of tankage, 800 tons of ground coral and 2000 tons of bone meal were used. The value of this large quantity of fertilizing material, together with the cost of mixing, bagging, freight and manufacturers' profit would probably bring the total cost to about $1,700,000.

It is seen that the value of the element nitrogen in mixed fertilizers applied during the past crop was greater than that of the other elements combined, being $604,200 against $528, 150, the total value of potash and phospheric acid used. Unfortunately the most expensive of the fertilizing elements is the one which, under certain conditions, is most liable to waste. Some of the ways in which either a loss of nitrogen may occur, or in which it may defeat the object intended may be summarized in a few words:—

1. Application of nitrogen in the form of nitrates in districts of heavy or uncertain rainfall:—While a considerable loss must have resulted in this manner in former years, it is safe to say that little, if any, of the nitrogen used during the past year has been lost from a too heavy application of nitrates under such conditions. Where nitrates have been applied to lands subject to occasional heavy rains, it has been added in small quantities more as a stimulant to meet special requirements.

2. Application as nitrates followed by heavy irrigation:— When nitrate of soda is used as a special dressing, the present tendency is to make more frequent applications of a smaller quantity than was customary during former years, thus run-

ning a smaller risk of loss from heavy watering. A considerable saving of this material has undoubtedly resulted from such a modification of practice and the cane has profited by receiving small doses as required, instead of excessive amounts at longer intervals.

3. Use of large quantities of nitrogenous fertilizer with the seed:—Very gratifying results have attended the use of such fertilizing material as fish scrap and tankage with the seed during the past year or so, and this method of fertilization seems to be growing in favor in many localities. As tankage and fish scrap of good quality are ordinarily used, there must necessarily be a limit to the quantity which may be applied in this manner economically—which limit would vary with the depth and nature of the soil and with the rainfall. When this material is thoroughly stirred up with the soil of the seed bed, the most proper conditions for nitrification are produced and nitrates must accumulate in the soil in considerable quantities before the roots of the young cane are sufficiently advanced to appropriate the supply. Heavy rains or irrigation, between the time of applying the fertilizing material in the seed bed and the time when the young cane begins to root, would cause a danger of loss from the leaching of nitrates. The percentage of loss would be materially less with tankage and fish scrap than with dried blood and ammonium sulphate in mixed fertilizers applied in the same way, the latter materials supplying the fugitive nitrate with more rapidity than the former.

The statements made in regard to this manner of fertilizing are not in the nature of a criticism, as the excellent results attained on several plantations bear the most substantial evidence of its value under certain conditions. The danger of loss is merely pointed out when excessive quantities are used.

4. Applying total fertilizer for the crop in one application to very young cane:—If the nitrogen of the mixture is in the form of nitrate of soda or other form readily nitrified such as ammonium sulphate or dried blood, a danger of loss would become imminent from such practice. Recent tests conducted at the Experiment Station and bearing on the rapidity of nitrification of ammonium sulphate showed that 50% of the nitrogen applied in such form was converted into a constituent part of nitrates within six weeks, and 80% within fourteen weeks. This degree of nitrification occurred within a soil which was kept very near the saturation point with water, a condition tending toward the retardation of nitrification. In another experiment with dried blood it was found that 47 per cent of the nitrogen was converted into nitrates during a period of three months. It is thus seen that if a fertilizer containing ammonium sulphate is applied to young cane of one or two months' growth, three or four months' later the soil contains nearly all of the added nitrogen in a nitrified

state, less that which has been appropriated by the young plants, or washed out of the soil by *irrigation or rains*. If the supply of nitrates is sufficiently small that it may all be taken up by the young cane, then during the subsequent growth of the crop the latter must rely entirely upon the nitrates produced from the original organic matter of the soil; if the supply of nitrates formed from the applied nitrogenous material is largely in excess of the requirements of the young cane, then there is a danger of loss by leaching. By applying the mixed fertilizer in two or three applications a smaller quantity is added to the soil at one time and the nitrates produced are not apt to be in excess of requirements. Regarding this point Mr. Wm. Pullar, of the committee on fertilization, writes: "I am strongly in favor of frequent applications where the rainfall is often excessive and where there is so much danger of loss by leaching. The extra cost of applying is not so very much and the results well warrant the expense."

5. Making late application of nitrogenous fertilizer and prolonging maturity of the cane:—That late special dressings of nitrate of soda, for instance, may stimulate the vegetative functions of the cane and retard ripening is too well known to be spoken of at any length. The best time to apply nitrate and insure juices of good purity is a question which must be solved by experience under the separate conditions of each plantation. Both the amounts and times at which nitrates may be used to best advantage is influenced in large measure by the natural nitrogen content of the soil and the size of the average crop of the fields in question.

6. Using excessive amounts of nitrogen:—By application of nitrogenous material to such an extent that a supply of nitrates is produced within a soil above the actual requirements of the cane not only makes a danger of loss through leaching imminent, but more of this element is taken up by the cane than is needful. This would constitute a loss of nitrogen which in some instances had been added to the soil in an expensive form.

7. The use of nitrate of soda in considerable quantities on fields receiving irrigation water of high salt content:—This cause of waste was referred to at some length in the report on fertilization presented at the last meeting of the Association, and is also discussed in the report of the Experiment Station for the present year. In the latter bulletin figures are given to show that in a test with excessive irrigations (the water containing 200 grains of salt per gallon) a large waste of nitrogen occurred within a very short time where nitrates were applied and a comparatively small loss in the same length of time where ammonium sulphate or dried blood were used. To each of three lysimeters 10 grams of nitrogen were added but in different forms, and the soils of the lysi-

meters received irrigation sufficiently heavy to prevent serious accumulations of salt. After four irrigations the nitrogen which had run to waste in the drainage waters was as follows:

Nitrogen applied as nitrate of soda showed a loss of 80.49%.

Nitrogen applied as ammonium sulphate showed a loss of 6.79%.

Nitrogen applied as blood of soda showed a loss of 4.59%.

These figures will give an idea of the relative percentage of loss of nitrogen in the different forms under heavy irrigation. Salt when present in the soil in quantities sufficiently low as to be of no serious injury to the cane, does not affect the activity of the nitrifying organisms to such an extent as to make the application of ammonium sulphate disadvantageous. On that account it is strongly recommended that where soils low in nitrogen are receiving brackish irrigation, the quantity of ammonium sulphate or organic matter (of good form) in mixed fertilizers be increased, in order that the quantity of nitrates applied as special dressings may be materially lessened. Such dressings of nitrate as are used under such conditions will remain a longer time in the soil if applied after irrigating rather than before.

Potash.—With respect to potash the tendency has been to increase the percentage of this element in mixed fertilizers during the last couple of years and favorable results following such change are reported from a number of plantations. Mr. Pullar, of the committee, writes:—"We have increased the potash content the past two years with good results and it ought to be higher yet, I think." The sugar cane is a great potash feeder, a fact which has been amply demonstrated by the chemical analysis of its ash. The average amount of potash used per ton of sugar grown with 15 varieties of cane at the Experiment Station was 150 pounds. The combined weight of the other so-called vital elements, nitrogen, phosphoric acid, and lime, taken up by the cane averaged 101 pounds per ton of sugar. Of the three varieties of cane, Lahaina, Rose Bamboo, and Yellow Caledonia, which are most commonly grown on these islands, the average amount of potash taken up per ton of sugar produced was found to be 111.6 pounds. Of this amount about one-third would go to the cane stalk and two-thirds to the leaf, a difference in requirements which is a most fortunate circumstance, for through plowing into the soil or burning the strippings and waste matters of the cane field, large amounts of this element are conserved for future use. Most of the potash applied in fertilizers for the last crop was in the form of sulphate, very little being used as muriate. The cost of the two forms is slightly in favor of the muriate, although under most conditions on these Islands the sulphate must prove the more economical of the two, through its superior fixing qualities and its smaller depleting action on the lime of the soil.

The principal ways in which this element might be used to least advantage would be as follows:

1. The application as muriate in districts of heavy or uncertain rainfall:—As is well known the muriate is not so quickly fixed in the soil as the sulphate and is more liable to waste. The same would hold true where heavy irrigations are applied, as for instance in the use of rather brackish water.

2. By applying large amounts of potash to lands poor in lime:—Lime is essential to the most advantageous use of potash and where the lime of a soil is very low it should be augmented previous to the addition of potassic fertilizers.

3. Through the use of potassium salts on heavy lands without first using lime:—Potassium salts often have a tendency to make clay soils more compact and on this account might result in producing more injury than benefit even on soils containing little potash. By improving the mechanical condition of such soils through a liberal application of lime in the caustic or slaked form, previous to the addition of potash, the latter element may be rendered more serviceable.

Phosphoric Acid.—While the tendency has been to increase the percentage of potash in mixed fertilizers, the phosphoric acid in many cases has been materially reduced. Phosphoric acid has one advantage over other fertilizing ingredients through its power of readily becoming fixed in the soil, and very little of this element applied in its most soluble form can be lost from the land during heavy rains or irrigation. When used in a soluble form in larger amounts than is required, through its insolubility following fixation, the excess remains in the soil to be drawn upon by future crops, and the soil is correspondingly enriched as regards the material. While indispensable to the cane, it is withdrawn in smaller quantities from the soil than is the case with the other fertilizing elements, about 15 pounds per ton of sugar being the average requirement for Lahaina and Rose Bamboo cane at the Experiment Station. The cane and leaves divide the amount in almost equal proportions so that a large percentage is returned to the soil after harvesting the crop. Unlike potash, however, the amount which is returned to the soil through the burning of the refuse of the field is chiefly in an insoluble form and does not possess any particular fertilizing value. Hawaiian soils as a rule stand high in phosphoric acid, but the element is locked up in insoluble forms. The object of adding phosphoric acid to the land, then, is not so much for the purpose of increasing the total stock of this element—such an increase would be infinitessimal—but to increase the amount which will be available for the crop. The greater the solubility of the form the more satisfactory should be the results. The value of insoluble forms varies chiefly with the fineness of their mechanical division and the amount of organic matter with which they are associated, both factors influencing in large measure the rapidity of decomposition and the resultant liberation of the phosphoric acid.

While judicious fertilization has helped in large measure to raise the average production of sugar per acre on these Islands, it has not been the only factor influencing such increase. The best results from fertilization have followed the most careful cultivation, and when proper conditions for the latter have been wanting through scarcity of labor, fertilizers have sometimes failed to respond in a satisfactory manner. Again through drought or other unfavorable climatic conditions, over which the plantation manager has no control, fertilization has at times been more than counteracted by such adverse circumstances. Mr. H. A. Baldwin, of the committee on fertilization, writes: "I doubt very much if fertilizing does much good when there is a shortage of water, and in fact it seems to result in the cane feeling such a shortage more." This experience has been shared by a number of managers at times who have had to contend with an insufficient water supply. It is under such conditions that cultivation would exert a potent influence, in lessening the evaporation of water from the surface of the field during a dry spell, and increasing the amount which might be used by the cane. The use of organic manures that would materially increase the humus content of the soil would add to its water holding capacity and tend to diminish the evil effects of drought. However, labor is not always plentiful enough to allow of such thorough cultivation, and the supply of waste organic matter from the mill and stables is too limited to spread effectively over so wide an area. The plowing in of trash on lands low in organic matter and where the absence of the borer would make such a course practicable, would be of unquestionable value in this connection.

The supply of labor may have a material effect on the manner in which fertilizers are applied, and managers feel that they must consider the most economical use of a limited supply of labor as well as the most advantageous use of fertilizers. Fertilization practices are modified accordingly in ways which will best suit the conditions with which the plantation has to contend. Mr. H. A. Baldwin, of the committee, points this fact out in regard to applying all of the fertilizer for the crop in one application, on account of labor considerations. Mr. Baldwin writes: "I think that better results are obtained when the fertilizer is applied in smaller doses two or three times than in one application as we have done. We have been obliged to put it on this way on account of shortage in labor." Mr. Baldwin, however, adds nitrate to his land as the cane seems to demand it so that the supply of nitrogen be dropped from further trial. The fact that beans, peas, and lupines can gather from the air a store of valuable nitrogen, which when applied in fertilizers is the most expensive element, should make green manuring a subject for careful consideration in many localities.

The chemical analysis of Mauritius bean vines at the Experiment Station, where conditions were found to be very favorable for their thrifty growth showed the following quantities of the various elements to have been taken up by the plants:

In Roots and Vines per Acre.

Total Mineral Matter	1294.48 lbs.
Nitrogen	290.43 "
Phosphoric Acid	43.97 "
Lime	159.82 "
Potash	143.19 "

These beans were planted at the end of October and plowed in during the middle of February, at which time the green pods were beginning to form. This species of the legume does well with little water, vines growing luxuriantly at the station for the last year and a half without irrigation.

Respectfully submitted,

C. F. ECKART,

Chairman, Committee on Fertilization.

Honolulu, T. H., November 17th, 1902.

REPORT OF THE COMMITTEE ON "EXPERIMENTAL STATION."

The committee on "Experimental Station" which reported last year presented an account of the work done at the station during the previous twelve months. Such report should, in the opinion of the present committee, emanate from the director exclusively, as he alone is responsible for and can give an account of the work accomplished. In accordance with this view and at our request the director, Mr. C. F. Eckart, has made a report to us, which is subjoined hereto, in which he very fully specifies the character and extent of the work done and the experiments carried out under his supervision, and the committee now reporting does not include him, as was the intention of the president.

The experiments completed and now being followed up are replete with interest for the sugar planter, and we take pleasure in expressing the opinion that Mr. Eckart is ably carrying out the work which Dr. Maxwell inaugurated, and has himself originated experiments which are well calculated to be of great value.

Some of the experiments are perhaps of more practical interest to those managing irrigated plantations than to the managers of plantations whose water supply is entirely dependent on the rainfall, but on the whole they are well worthy of study by all who have to do with the cultivation of sugar cane. Apart from the irrigation experiments there are being carried along interesting experiments in fertilization, stripping and other agricultural operations, besides which a large assortment of canes—many of them strangers to Hawaiian plantations—are being carefully raised and when grown are scientifically compared as to weight, sucrose content, etc., with the better known canes, and their value thus determined.

We think it will be found that there are several varieties of cane at the station which will prove most acceptable additions to the somewhat limited number of species to which our plantations have for so long confined themselves. Just as the Yellow Caledonia has, on many plantations, supplanted the Lahaina and Rose Bamboo so it is quite likely there will be found at the station a cane or canes even more desirable than the Yellow Caledonia promises to be.

The director points out in his report on "Varieties of Cane" that the tests made at the station "cannot be taken as a standard of comparison in sections of the Islands where radically different climatic conditions prevail," and he suggests that promising varieties should be sent to different localities there to undergo further test. Your committee regards this as an eminently practical suggestion which should be acted upon, and it believes that every plantation should have a cane nursery where experiments with different varieties of cane might be conducted independently of those carried on in the Association's station, and comparisons of results in different localities might then be made with much profit.

We regretted to observe that at the station, as on several of our plantations, there is a considerable amount of blight and insect pest on some of the cane, so that in sending away seed the director purposes to exercise the greatest care and to allow none to leave the gardens until sufficient time has elapsed for the development of any larvae they may contain, and not then except after thorough fumigation, so that there may be no possibility of conveying to any plantation undesirable insects or diseases.

It is noteworthy that some canes appear to offer considerably less attraction to such destructive insects as the "leafhopper" than do others, and we would like to see very careful observations made both by the director and by our entomologists into this important subject, for, needless to say, if we can raise a cane which is a desirable sugar producer and at the same time not liable to the attacks of insects, the gain will be immense.

In the laboratory, as in the field, your committee found that intelligent conduct of the business of the station which makes it of so much value, and we were pleased to be informed that there has been a large increase in the number of soil and fertilizer analyses made during the past year, which is satisfactory evidence of the growing belief in the value of our laboratories. We were also pleased to learn that some of the younger men who have recently gone into sugar making on plantations are availing themselves of our laboratory during the "off season" for the purpose of familiarizing themselves with the chemistry of sugar manufacture and the ordinary methods of soil analyses, etc., etc. So far as it is possible for the Association's chemists to impart instruction without interference with the proper discharge of their particular duties we are disposed to encourage the use of the laboratory by a limited number of students for whose instruction a fee should be charged, a part of which should go to the instructing chemist and a part to the Association for the use of its laboratory, etc.

The cost of operating the Experimental Station for the year ending October 31 last was $11,002.46 as detailed in the annexed statement of the director. We regard this expenditure as very reasonable when compared with the results attained and the advantage to the sugar industry afforded by this station, and as fertilizer manufacturers contribute fees for analyses the net cost of operating the station is quite modest.

At present there are two assistant chemists, but as there is an increasing number of analyses the director desires to secure the services of a third assistant, and we recommend that he be allowed to engage such additional assistance for so long as it may be required.

In conclusion we take pleasure in testifying to the conscientious and intelligent direction of the Experimental Station, both in field and laboratory, and we suggest that plantation managers and others interested in the sugar industry should not fail to visit the station whenever opportunity affords, as there is always much of interest to be seen there and the gain to both managers and director by the more frequent interchange of ideas and experiences can be productive only of good to the industry. We also desire to draw the attention of all members of the Association to the printed report of the director on the work of the Experimental Station and laboratories for the past year.

F. M. SWANZY,
F. A. SCHAEFER,
W. M. GIFFARD.

Honolulu, November 13, 1902.

TO THE PRESIDENT AND MEMBERS OF THE HAWAIIAN SUGAR SUGAR PLANTERS' ASSOCIATION.

GENTLEMEN:—With regard to work of the Experiment Station for the year 1902, I beg to submit the following report:

FIELD WORK.

The Experiment Station field is divided into plats on which are conducted experiments which may be characterized as follows:

Stripping Experiments:—Four plats of Lahaina cane planted July 27th, 1901 and grown under identical conditions except with regard to stripping. The plats are designated as follows:

Plat 1—No stripping.
" 2—One stripping; June, 1901.
" 3—Two strippings; March and October, 1902.
" 4—Three strippings; March, August and November, 1902.

The cane in these experiments will be harvested in May, 1903.

Irrigation Experiments:—This series of tests is being conducted to note the effect of different volumes of water applied at varying intervals. The cane was planted in June, 1901, and will be taken off in May of next year.

4 rows are receiving three inches of water per week.
3 rows, 2 inches per week.
3 rows, 1 inch per week.
3 rows, 3 inches every three weeks.
3 rows, 2 inches every two weeks.

Daily readings are taken of the soil moisture in these tests with a soil hygrometer, the electrodes of which are placed at a depth of one foot in the furrow.

Fertilization Experiments:—These are twenty-six in number and cover a variety of tests, the object being to determine through the application of varying quantities of the different fertilizing ingredients, the most suitable forms and economical mixtures. As far as laboratory facilities will allow, a study will be made as to the amounts of the elements that have been taken up by the cane on the respective plats. The experiments were started on June 27th, 1901 and the cane will be harvested in May, 1903.

Salt Experiments:—Six plats of cane are being irrigated with water containing 200 grains of salt per U. S. gallon. An investigation will be made as to the effect of ground coral and gypsum on the growth of cane irrigated with salt water, as well as to the most suitable form of nitrogen to apply as a fertilizer under such conditions. These tests will be concluded in 1904.

Four plats are receiving irrigation water containing varying amounts of salt; 50, 100, 150, and 200 grains per gallon being the respective quantities. These tests were started to determine the effect of brackish irrigation on the growth of cane and the quality of the juice. The cane on these plats will be cut in May, 1903.

One Year Experiments:—Two plats, one of Lahaina cane and the other of Rose Bamboo were planted in February, 1901, rattooned February, 1902, and will be replanted in February, 1903, the last harvesting will occur in February, 1904. The object of this experiment is to compare the total yield of three one-year crops with two ordinary crops of these varieties.

Variety Experiments:—Seventeen varieties of cane were planted on June 5th, of this year and will be subjected to the same conditions as regards irrigation, fertilization, etc. in order that their relative productive value may be determined.

The varieties represented in these experiments are:—

1. Striped Singapore.
2. Big Ribbon.
3. Yellow Caledonia.
4. White Bamboo.
5 Yellow Bamboo.
6. Demerara No. 117.
7. Demerara No. 95.
8. Demerara No. 74.
9. Queensland 8 A.
10. Queensland 7.
11. Queensland 4.
12. Queensland 1.
13. La Purple.
14. La Striped.
15. Tiboo Merd.
16. Gee Gow.
17. Cavengerie.

New Varieties:—Twenty-six new varieties are being grown for seed to be used in future experiments. They are as follows:

1.	Queensland	B No.	208.
2.	"	B	3.
3.	"		3.
4.	"		6.
5.	"		9.
6.	"	B	244.
7.	"	B	306.
8.	"	B	176.
9.	"	B	156.
10.	"	B	147.
11.	"	B	8 A.
12.	"	B	8.
13.	"	B	5.
14.	Demerara		1135.
15.	"		1483.
16.	"		1937.
17.	"		115.

18. Demerara 116.
19. " 145.
20. Rappoe.
21. Dark Bamboo.
22. Daniel Dupont.
23. Unknown.
24. Striped Tip.
25. Bangan.
26. Badilla.

Lysimeter Experiments:—Fourteen of these experiments were concluded during the past year, yielding data on the relative solubilities of the soil elements in fresh and salt water; the influence of salt on the nitrification of nitrogenous fertilizers, the fixing power of fertilizing elements; and the limit to the amount of salt in a soil which will permit the growth of cane.

LABORATORY WORK.

The work of the laboratory during the past year may be summarized as follows:

Samples analyzed between November 1st, 1901 and November 1st, 1902:

Soils	91
Fertilizers—from Plantations	229
From Experiment Station	10
Waters	179
Cane Juices	31
Cane Fibres	6
Cane Ash	56
Molasses	3
Miscellaneous	9
Total	614

The number of fertilizer and soil samples received by the laboratory for analysis showed a considerable increase over the number received during the preceding year.

The findings of the laboratory showed a shortage of approximately $9,000 in the guaranteed value of fertilizers. This indicates a material improvement over former years as will be noted from the following figures:

Year.	1900.	1901.	1902.
Fertilizer samples received	75	189	229
Difference between valuation of Manufacturer and Experiment Stations	$12,000	$11,000	$9,000

During the past year the total number of samples received by the laboratory for analysis was 614 as compared with 449 samples received during the preceding year. As duplicate analyses are made of samples with but few exceptions, the increased amount of work in the laboratory may be represented by approximately 330 analyses. In the judgment of the director, the number of laboratory assistants should be increased by one additional chemist to better meet the increased demands on such branch of the Experiment Station. This would allow more prompt reports on soils and fertilizers and at the same time permit the execution of more experimental work.

Reports:—Two reports have been issued by the Experiment Station during the current year as follows:

(1) Precautions to be observed with regard to cane importations.

(2). Work of the Hawaiian Experiment Station.

Respectfully submitted,

C. F. ECKART, Director.

Honolulu, H. T., Nov. 1st, 1902.

NOTES ON INSECTS INJURIOUS TO CANE IN THE HAWAIIAN ISLANDS.

In May of the present year I furnished Mr. C. F. Eckart, Director of the Experiment Station with a short account of all the insects known to attack cane in this country, and also mentioned some of the worst enemies found in other countries, the importation of which is particularly to be guarded against. Since that account was published I have received at various times, and from different plantations, samples of cane attacked by one or more of the species therein enumerated, and on these I shall add some further remarks, since no new enemy of any great import has since been forwarded for examination.

At the end of this paper is subjoined a list of the insects injurious to cane taken from my former paper and in which the scientific names of the various species are, when possible, given and to which reference must be made for these names, since only the popular ones are used in this account.

The leaf-hopper of the cane. (Bug (1) of list).

This small insect is highly injurious to cane and its destructiveness threatens to exceed that of the cane borer beetle (1) of list. Its habits appear to be quite identical with those of a pest well known in the cane-fields of Java, but whether the insects belong to the same species is very doubtful. (See Note A below). Specimens of the Hawaiian insect have been sent both to Washington and to England for examination, but unless identical with one of the several cane-infesting species, it is not very likely to be known to scientists, since it belongs to an obscure and unattractive group of insects very little collected or studied in tropical countries, where there is usually an abundance of more showy creatures.

The worst leaf-hopper of Java (for that country has several species), does not appear to be a native of that country but to have been imported from Celebes, and whence the Hawaiian insect was accidently imported is at present unknown. It is of the first importance to find out the native country of our species if it can be learned, for unhappily it may be necessary to specially send in search of its natural enemies or parasites, and for this reason specimens have been sent to those most likely to be able to furnish information on this point.

Even should this most desirable information not be forthcoming, yet natural enemies may yet be procured. Certain lady birds inhabiting Australia, and no doubt other countries, are known to prey on leaf-hoppers, and some of these are probably not particular as to the exact species of leaf-hopper they attack. With internal parasites, however, unless procured from the species of leaf-hopper here present, or from some very similar species, there is little chance of success, and for these parasites the native home of the leaf-hopper must be first discovered.

There is at the present time one enemy of the leaf-hopper, which is of considerable importance. This was first found in the gardens in Honolulu, as a rare insect, seven years ago, and it was no doubt accidentally imported some few years before that time. It would naturally take some time to increase from one or two accidentally introduced individuals to such numbers as to become noticeable.

This insect belongs to the same group as the best-known of the so-called "Kissing-bugs," of which the mainland papers of a few years ago contained sensational reports. When mature it is rather a showy insect, green and red, and with a rather strong recurved beak. It is certainly an American insect, because it belongs to a group which is American only, but it apparently has not yet been collected there, and is consequently first described (under the name of *Belus peregrinus*) from these Islands, although evidently a recent importation from the mainland. This bug is a very general feeder, preying on many other insects besides leaf-hoppers. It may sometimes be seen on citrus trees with one of the lady birds, which preys on the aphis of these trees, transfixed on its beak, while it is itself at times an eater of aphis.

Nearly every sample of cane badly infested with "hopper" that has been sent to me has contained specimens of these predatory bugs, and Mr. Andrew Adams informs me in a letter that "the Kissing-bugs appeared in large numbers," following the attack of the leaf-hoppers this summer at Kahuku.

Aggravating as it may be to the grower of orange and lime trees to see this bug sucking the juices of the lady-birds which would quickly rid the young shoots of the seasonal swarms of aphis, yet on the whole it must be considered beneficial, and in the cane-fields is unquestionably of very great value.

The only other enemies of the leaf-hopper are the various spiders which swarm in some cane-fields, and in their webs many of this pest may be seen entangled. Possibly too they may be eaten by the earwigs which also are sometimes common on badly affected cane.

At present the leaf-hopper is only known to be present on Oahu and Kauai, on the former island indeed it is now ubiquitous. As the mature insect can fly fairly well, it is certain to spread over the whole of any island, where it has once established itself. By natural means, however, it would be very unlikely to cross the channels between the different islands, and its establishment on the windward islands is only likely to be brought about by means of the inter-island traffic. Certainly the utmost care should be taken to prevent its being carried to these Islands, if it has not already been established there, and it is very desirable that information on this point should be obtained.

The signs of leaf-hopper attack, when the insects become numerous, are very characteristic, on account of the minute red or brown discolorations where the leaf is punctured, and by large patches of the red color, extending sometimes over the greater part of the surface. In bad attacks too the cane becomes blackened with the usual fungoid growth on the excretions of the insects, but the blackness follows also bad attacks of aphis and other insects, and so does not alone absolutely prove the presence of leaf-hopper, as do the red discolorations.

(See note A below for comparison of habits of Javanese species.)

Formerly I supposed that the eggs were laid only in the leaf, in the usual chamber excavated by the oviposetor of the female beneath the surface. I have since found, however, that their egg chambers are sometimes found in extraordinary numbers in the stems of the cane. Therefore a single stick of cane taken from Oahu or Kauai to other of the islands, unless rigidly examined, may contain enough hoppers in embryo to thoroughly stock these. Hence too the omission of leaves in packing seed cane is no precaution against the introduction of foreign leaf-hoppers of similar habits to the one already here, as we had supposed.

As a matter of fact, it was in examining some cane imported from Queensland that I first became aware of this habit of the leaf-hopper in laying its eggs in the stem as well as the leaf. This seed cane was examined by me on its arrival, and at first sight appeared absolutely free from pests. Each piece was wrapped separately in clean paper and paper only was used in packing. In several of the pieces the minute egg-chamber scars were found in great numbers, in some less numerously, though they could only be seen at all when the microscopic fungus or mould which had grown on the surface had been rubbed off. These chambers contained many healthy eggs, and a few young insects were present which had hatched on the journey. With much regret it was decided to destroy this fine seed-cane, because, (1) after treatment with hydrocyanic gas other young ones hatched next day from the subcuticular chambers; and (2) in their immature state the identity of the Queensland species with the one here could not possibly be determined. No doubt they might have been reared to maturity in captivity and their identity or otherwise established, but long before they could have reached this stage the seed-cane would have been dead.

It is highly expedient that if new varieties of cane are to be introduced systematic experiments should be carried out with the hydrocyanic gas or other treatments to establish (1) how severe or prolonged a treatment the average seed-cane will stand without injury; (2) how severe a treatment is necessary to kill the most hardy internal-feeding insect, a good example being the larva and beetle of the island cane-borer.

As other cane-borers, in many ways similar to our own and fully as injurious as this, or even more so, are known in other countries, and one of these was found in cane imported from Demerara by Prof. Koebele, as he brought to your attention a year ago, the importance of subjecting all imported cane to treatment sufficient to kill these, provided such treatment will not injure the cane, is evident. Badly infected cane like the Demerara sample would naturally be destroyed even on casual inspection, but cane containing a few minute larvae of a borer would probably show no external signs of attack, and yet these might be sufficient to stock the whole islands with a destructive pest.

To return to the leaf-hopper, there is little doubt that its destructiveness will vary very much with the locality and according to the season, and it is by no means certain that it has as yet, even on Oahu multiplied to the fullest extent, for it is certainly, comparatively speaking, a recent introduction into the islands. The loss it occasions on some plantations is already very considerable, and it is probable that natural enemies will have to be sought for it.

If the leaf-hopper of Queensland, found in the seed-cane above mentioned which was destroyed, is the same as the one here, and yet does no damage in that country, it very probably has naturalized enemies there which keep it in check.

It may be, however, that there too it is only a recent introduction (affecting as it did a special cane marked "Mauritius seedling"), or different climatic conditions may prevent its undue increase.

In the hope of obtaining some information on this point, inquiry has already been made by Mr. French, the Government Entomologist of Victoria, who, if not able to supply this himself, may be able to put us in communication with others who can.

THE CANE-BORER (Beetle (1) of list.)

In my former report I expressed a decided opinion that the cane-borer was introduced into these Islands and not indigenous. I am now able to show how easily this may have been done. A few months ago a large number of cocoanuts were imported from Samoa for seed. These on superficial inspection appeared to be nearly all free from insect attack, but careful examination of the interior of the woody drupe, and of the parts adjoining the adherent calyx revealed a small fauna of insects. In a paper (as yet unpublished) I have enumerated over thirty species of insects obtained from this consignment of cocoanuts alone, and no doubt not less than fifty different kinds were present, counting minute larvae which could not be identified and other species so small that they could not be found after the cocoanuts had been treated for their destruction. Amongst these our cane-borer was conspicuous, many old and young larvae, as well as perfectly developed male and female beetles being present. As it is certain that seed cocoanuts have been in the past more than once imported from Samoa, Fiji and Tahiti (all inhabited by the borer), without any critical examination, it is quite probable that the borer was introduced in this way. In the Samoa cocoanuts at least three other boring beetles were present, any of which might very likely attack cane, and the Fijian nuts were by no means free from insect attack. In the earth adherent to the bark of some of these nuts larvae of a beetle allied to our so-called "Japanese beetle" were also present. It may be noted that many palms, as well as some grasses and bananas are likely to bring insects injurious to cane.

As matters stand, Territorial legislation is very necessary to guard against injurious insects which might be imported from the various States, as well as stringent rules in the case of importations from outside countries. In no case whatever should plants be allowed to be imported with soil, as is so commonly done. Moss wrapped around, or some substitute for this, wrapped round the roots is far preferable, but even this often requires treatment, being frequently alive with various insects. Seed-cane should be wrapped each piece separately, in clean paper, for although even this is no preventative against borers or certain leaf-hoppers, yet it excludes a number of species, which attack the leaves and tops. The latter should never be used for packing material. For cane a small but properly constructed fumigating house might be built at the Experiment Station, which would not only be of use for cane imported from without, but also for seed cane sent from the station to the other islands.

Mr. Adams, whom I have quoted above respecting the leaf-hopper, has written me the following note concerning the borer on Kahuku Plantation, and his note on this, as well as that on the mole-cricket given below, is of much interest.

"This year we tried killing off borer beetles in one field on a wholesale plan and the experiment was successful. One of the Kahuku fields most damaged by borer was a small piece of about 25 acres in area. The field was cut in May of this year and the trash allowed to remain on the ground. Frequent showers stimulated a heavy growth of rattoons. Early in September, when the rattoon were four and five joints high we burned off the trash and examined the field. In the first sheaf opened were found six dead beetles, in the next four, in the next six. The same conditions prevailed through the field. The canes were found spotted with eggs and were cut down with hoes, raked into piles and burned."

JAPANESE BEETLES. (Beetle (5) of list.)

In one instance on Oahu this beetle was reported to be eating the leaves of cane and doing some damage. It was proposed to spray with poison, but I have not heard as to the result. No doubt the attack was accidental, the earth probably being full of larvae at the time the cane was planted, and the beetles resulting, were forced to feed on this in the absence of some of the common weeds which are amongst their natural foods.

MOLE-CRICKET. (Cricket (1) of list.)

On Kahuku Plantation, Mr. Adams writes me:

"A small five acre portion of one field is badly infested with Mole-cricket. This piece of land is separated from a rice plantation by a drainage ditch and requires little irrigation. After planting this year only about 25% of the cane came up. In many furrows no cane at all appeared. On examining the seed it was found that the eyes were eaten off by the Mole-crickets. The piece was replanted with the same result. We replanted a second time. This time the seed canes were placed in the tops and along the sides of the hills with about half the seed above ground at an angle of about 45 degrees. As fast as the eyes above ground developed the canes were covered thinly with soil until they were well developed. The field now has a good stand of cane upon it. The adjacent rice fields are apparently not affected."

On Ewa Plantation, Mr. E. D. Tenney wrote to me of a similarly restricted attack and samples of cane sent were quite riddled with burrows formed by the cricket. The crickets themselves were all immature, the wings being only partly developed, in fact in the penultimate stage. I believe the attacks of the Mole-cricket on cane to be purely accidental. Their home is in cane-fields generally along the ditches, and they are either driven from there by excessive floods, or perhaps sometimes from their drying up. In such cases they emigrate into places in the adjoining fields where the moisture is suitable and the cane is attacked by them as a rule only as it interferes with their subterranean passages. The Mongoose preys freely on these as it does on roaches, but I know of no other enemy. No doubt they could be largely exterminated by prolonged flooding of an affected field, for they could easily be collected and killed when driven from their burrows in this manner. Probably too, they could be destroyed by the use of mineral poisons. I believe the insect was reported on by Prof. Koebele some years ago, but I have not the report to hand. It is referred to in Kruger's work from which I have quoted below. (Note B.)

CATERPILLAR OF PYRALID OF MOTH. (Caterpillar (1) of list.)

Cane infested with leaf-hopper on Kauai was at the same time badly affected with caterpillars, (Caterpillars No. 1 of list.) These were found in numbers in the young leaves of the tops, eating into and fouling these with their excrements. None of those kept for breeding were affected by parasites.

LIST OF INSECTS, MORE OR LESS INJURIOUS TO CANE IN THE HAWAIIAN ISLANDS.

Beetles—
- (1) The cane-borer (Sphenophorus obscurus).
- (2) Long-horned Beetle, (Aegosoma reflexum).
- (3) Small borer, (Hypothenemus sp—).
- (4) Nitidulid Beetle, (Haptoucus sp?).
- (5) Japanese Beetle, (Adoretus umbrosis).

Caterpillars—
- (1) Omiodes acaepta and probably the very closely allied species.
- (2) O. epicentra.
- (3) The "peelua" (Spodoptera mauriyia).

Flies—
- (1) Four-banded fly (Fam. Ortalidae, perhaps Euxesta annonae).

Crickets, Etc.—
- (1) Mole-cricket (Gryllotalpa africana).
- (2) Short-horner grasshopper, (Oxya velox).
- (3) Long-horned grasshopper, (Xiphidium fuscum).

Bugs—
- (1 and 2) Leaf-hoppers (2 species) (Fulgoridae).
- (3) Plant-louse, (Aphis sp?).
- (4) Mealy-bug, (Dactylopius sp?).

Note "A."

W. Kruger in his work "Das Zuckerrohr und seine Kultur," separates the three species of Javanese leaf-hoppers by the length of the wings in the table of species there given.

If I understand his description rightly, the Hawaiian insect can be none of these. There is, however, confusion in two parts of the work in these descriptions, for in one the most injurious species with habits like ours is said to have uniformly dark wings (p. 344), and in another to be only spotted with dark (p. 312). It is therefore to be regretted that the paper containing the original descriptions is not to be procured in this country, for this would have saved the delay necessitated by sending away specimens for identification.

Kruger's account of the habits of the *Dicranotropis vastatrix* agrees well with those of our leaf-hopper.

"Lebt in Gemeinschaft mit den Larven zahlreich hauptsachlich hinter den Blattscheiden des Zuckerrohrs und sticht diese und die Blattnerven an * * * Die Umgebung des Stiches farbt sich rot oder braunrot," etc.

Note "B."

The brief account given by Kruger of the attack of the mole-cricket on Oahu reminds me of that observed by Mr. Adams at Kahuku. I believe Kruger's account is based on observations made some years ago by Prof. Koebele at Waimanalo. He says: "Auch von Oahu wird das Auftreten einer Gryllotalpaart in grosser Menge in Fenchten Distrukten vermeldef, die dadurch erheblich schadet, dass sic sich in die frisch ausgelegten Stecklinge bohrt, auch die Augen derselben ab—und die jungen Sprosse unter dem Boden anfrisst, so das die Pflanzen traufig absterben." Flooding the field and killing the crickets is the remedy suggested.

In the sample sent from Ewa the eyes were not specially attacked, but each piece of cane was much excavated by the borings and the borings were coated with mud carried into them.

R. C. L. Perkins.

November 15th, 1902.

REPORT ON FORESTRY.

Gentlemen:—In tendering you the following report on forestry, I beg to chiefly confine my remarks to the present condition of that large forest area in Hamakua district which suffered so severely by the disastrous fire of 1901. This fire started on the 3rd of July and burned more or less rapid until October, when after many attempts and much labor expended to suppress its ravages, it finally succumbed to the influence of heavy rain-storms then setting in. Not, however, until many thousands of acres had been destroyed and in several places large areas burned a second time during those months of drought.

At the time much conjecture existed, as to what would be the issue of such a fire in the forest after cooling off. To all appearance during the burn, indications pointed that the surface soil and humus would be entirely destroyed, although happily this has not been the result. The species of trees chiefly in evidence are Ohia, Opeko, with frequently a Koa dotted amongst them, underbrush of Aeae-vine and ferns in variety. Where ferns and vines grew thickly the fire passed rapidly along on the surface scorching everything in its path, but from the shade afforded by such undergrowth, and the root-system of Ohia and Koa being deeper than most of Hawaiian trees little or no underground burning followed, other than where fallen logs or decayed trees afforded material for a blaze; which lasted sufficiently long to heat up the surrounding soil.

The Ohia as a rule when felled by axe or saw, is the producer of vigorous coppice, although, in this instance I regret to report no indication of such a source of reproduction. The boles of many trees have been examined but in not a single instance could I find an eye with life, although, the past season has been all the forester could desire, for both moisture and temperature. With Koa and other varieties of timber throughout the burn similar conditions exist. Although, but a small area of the burned forest was traversed by me, I feel satisfied that for reproduction either by seedling or coppice, without artificial aid, there is but little, if any, hope.

Looking from an elevated position over this burned forest, offers a sight to be deplored, not a single green leaf is to be seen on each 2000 trees now standing throughout the burn; rather conveying the idea of a decidious forest in mid-winter, than the field of a year ago covered with tropical vegetation and healthy trees.

It is surprising to see how quickly the surface is becoming covered with weeds and grass, but of a class not favorable to the growth of tree seedlings whose life germs may be hidden underneath. Ageratum, Verbena, "Honohono" and "Hilo-grass" strive for supremacy. Traces of tree seedlings were eagerly and repeatedly looked for, although, I failed to find a single sprout on all of the surface examined. In this I was deeply disappointed, as I hoped to find on such a clean surface numerous seedlings that would be enabled to sprout and keep pace with the surrounding growth. It is evident that with such intense heat during the burn, the germinating qualities of seed in soil has been destroyed, and much of last year's seed crop still remained on the trees while the burn was at its height. In this class of forest there are but few, if any, winged seeds, while the birds frequenting these elevations are honey-suckers thus offering no immediate prospects of natural reproduction being hastened from those sources, other than what seed may be carried by the winds for a short distance in the neighborhood of narrow belt yet remaining, of healthy forest.

Facing the question which confronts us? Is it useless to assist in renewing this forest, or look on and see it disappear, as large areas of the natural forest has already done. It takes little of forest knowledge to see that there is but a very few years and a less number of hundred feet in margin belt of forest, between the bare plains and the plantations of Hamakua Mill Co., Kukaiau Plantation and Ookala Sugar Co.'s lands.

Some thousands of acres are now staked off as homestead lots in the forest immediately above the lands now settled on, which in a great many cases are already cleared of their timber trees, or where not entirely denuded the trees have been so severely root and branch trimmed that they look more dead and alive. The bulk of the forest burned, is Government property in which case it seems something should be done, and that cannot be done too early to create a reserve on at least part of the forest land, so that the high taxable value of adjoining agricultural land may be maintained. There never has been a better opportunity offered than now, for introducing on this stretch of country, a mixed plantation of native and exotic trees. The surface in many parts is clear of vegetation which would arrest the growth of young trees, while in a short time this will not be so, as Hilo grass will predominate. Horses and cattle run losely over the land and anything in the shape of fern growth, the natural nursery for tree seedlings, will be quickly destroyed by those animals.

First aims should then be, to have, whatever area may be set aside for forest, strongly fenced off, and cattle, or stock removed.

Planting of trees to say the least of it is expensive, although at the present time on this land much could be done by seed distribution. The soil is wonderfully rich and by discrimination in seed selection many parts could be reforested, with but little expense. The use of a small plow and two animals to scratch furrows say 8 or 10 feet apart, followed by a man with hand seed box, who could deposit seeds 4 to 6 feet apart in those furrows is a method by which a thick forest could quickly be established if done now. In a year hence vegetation will be so dense that successful use of a plow will be impracticable and the only method available will be planting of trees, by hand, at a great expense per acre.

As already noted the bulk of forest lands are still under Government control, while it lies in the hands of that body, to preserve and renew at least, part of the large tract destroyed. Depletion of the forests at some distant date means the ruin of this country, for although, some consideration has been bestowed on tree preservation in the laws relating to homesteads it is not enough, the number of trees is not sufficient. Where a land owner finds a tree interferes with his crop it is destroyed and the few left for shelter or shade are so severely root-trimmed that their life is limited to but a few years. On the tract of new homesteads cut up through the burned district belts of forests may intersect, but unless the base of a new forest be established and protected, from stock ranging, their existence will be, but in name, and for practical purposes of shelter or conservation of moisture entirely useless.

Year after year passes, while at the same time the forest steadily and surely is being depleted from both lower and upper sides. Eventually in some of our Island districts this denuding will show its serious effects; then both local Federal authorities will realize that forest reserves will be more difficult to handle than now, when the bulk of it is under their direct control.

Unfortunately for our Island forests, little of it is valuable as a source of revenue, were it otherwise, and made up of rich sandal wood, camphor, or lumber wood having a marketable value, then at the outset planting and preservation could be carried along from the proceeds of mature crop. As it stands today, however, forest reservation of reforesting of destroyed tracts, must be borne to a great extent with an eye to its future value as a timber producer, and presently by its influence in maintaining taxable values of adjoining lands, in sheltering of crops and ameliorating of climate in immediate neighborhood, as well as general conservation of water in the wood-land valleys and ravines.

Respectfully yours,

D. Forbes,

Chairman, Committee of Forestry.

REPORT ON FORESTRY.

To the Trustees and Members of the Hawaiian Sugar Planters' Association.

Dear Sirs:—Having had no opportunity of meeting the other members of your committee on forestry. I shall make such observations as personally occur to me, as important enough to engage your attention.

The question of forestry presents many phases and having been so much written upon in times past, it seems difficult to present anything new, but as nature and things are ever-changing and upsetting man's theories, we may learn something from theories thus corrected, as well as from theories proved to be incorrect by experience.

It may be wise to lay aside some of the disputed points as to the blessings of a forest, as there are enough undisputed points to justify their production and preservation and confine ourselves to the most prompt, economical and profitable way of growing and protecting them, including where they should grown. These points may profitably be discussed.

This kind of discussion should encourage forest growth as it would give us the experience and practical knowledge of many minds, although all may not be of the most scientific or economical kind.

We are now having a rather new encouraging prospect for a better knowledge of forestry, viz: The people of the United States are awakening as to the value of forest, and are maintaining forestry schools and our Government is also taking a hand, by encouraging and spreading a knowledge of forestry by which means scientific forestry men, will be multiplied and forestry knowledge increased.

What we may say respecting forests, is intended to apply mainly to these Islands. We commence, by stating that it is neither wise, nor economical to depend upon nature to plant or replant our forests, for the one reason, that she has not planted the more valuable, nor the more rapidly growing trees in Hawaii, and if permitted to plant again, she will do it with our slow growing Hawaiian varieties which are almost valueless when grown, save to bear the honored name of "Forest." A natural forest of Hawaiian trees, requires five times as long to grow to the same size as more thrifty varieties. If the later is of a valuable variety, it will be worth many times as much as a natural Hawaiian forest growing the same length of time. In other words, a forest set by man with thrifty trees, will grow as much in ten years as a natural Hawaiian forest will grow in fifty years and will be worth more money. These facts should command attention. I will show any one that will visit me in Hamakua, Hawaii, that these are facts. I give for proof the following: About fifty years ago, we are told, during a prolonged drought, a fire swept over several thousand acres of what was then the Hamakua forest. Much of this burnt overland, is now a young Ohia forest, the trees are now after fifty years' growth hardly large enough to make one telegraph pole each. About eight years ago Kukaiau Plantation Co. set a number of Australian gum trees. They are now by actual measurement over seventy feet high, and each would make two good telegraph poles. These trees will average 12 inches in diameter at the stump. Both the Ohia and the Gums are now to be seen, eight years and fifty years, and tree for tree the gums are the more valuable.

Another reason why other and more valuable variety of trees should be sought for Hawaiian forests, is, the native trees (Koas and Ohias), have so many destructive enemies they are rapidly dying out, and we have no assurance they will not continue dying more and more as the years go by.

The Koas of Hamakua having been dispoiled by worms so many years, are now dying by hundreds of acres. The Ohias that had a thrifty appearance a few years ago are now dying in parts of the old forests where stock has ranged and where no stock has ranged for many years, if ever.

From the above it may be seen the new and more valuable forest may be grown so quickly and chiefly, that no regrets should long worry us, when our old forests disappears. As all land owners may know, that by a comparative small outlay, they can have firewood, fence posts, bridge and other timbers, and a valuable forest, in a short time without waiting one hundred or more years for nature to plant and grow it for them.

The next question to be considered is, where shall new forests be set, and what part of our natural forests should be preserved.

President Roosevelt in his first message to Congress says: "The preservation of our forests is an imperative business necessity. We have come to see clearly that whatever destroys the forest, except to make way for agriculture, threatens our well being." I will quote no other authors, as this truth is self-evident, "that whatever destroys the forests, except to make way for agriculture threatens our well being."

That is, if our forests are not on agricultural lands let them be preserved. If they are upon agricultural lands they must give way to agriculture, when required for that purpose. Man by his labor gets his living from the soil. We read man was sent "forth from the Garden of Eden, to till the ground from whence he was taken." This shows us if we want to set or protect a forest by law, we must be sure it is not wanted for agriculture, as the curtailing of the agriculture of these Islands will curtail their wealth and prosperity. Their wealth comes from their soils. Of course we are only discussing about legal reservations set apart by territories, states or the general Government, not to effect private land owners.

FOREST PROTECTION.

Our next and most important question to consider, is the protection of forests from the depredation of stock, of fire, of worms, of man, etc. No doubt man is the greatest destroyer of forests, but he does not do it for fun, or deviltry, but for some good purpose, usually from necessity to maintain his existence, he must remove the forest to get at the soil. Man's living comes from the soil, but it cannot be obtained if the soil is covered with a forest.

It is by labor the forests of the Atlantic slope of the American continent have been removed and the land tilled, so that millions of the human race,—men, women and children are fed and clothed, and scores of millions of useful animals are there yearly produced for the good of man, and numerous thrifty cities, towns, villages, manufacturing plants, farm building, common roads and railroads have been built where the forests once stood, before the forests' removal, only a few savages and wild animals could maintain themselves, where now such great wealth exists and large number of civilized people reside, which could not have been done only by removing the forests and tilling the soil.

So I think man should not be charged to be a wilfull destroyer of forests under such circumstances, but rather should be credited for his industry, skill and perseverence under difficulties. Man should also be credited as a friend to forests when taking a district like California with nine-tenths of its habitable area without forests and covering it with forest trees, fruit trees, vineyards, grain fields, cities, towns, etc. The only thing worth noting of man's being a destroyer of forests comes from his carelessness in the use of fire. The fact is most of the destructive forest fires of the world comes through man's careless use of fire, through his smoking, his campfires, his railroad engines, etc. This was the case last year when so large a part of Hamakua forest was destroyed.

It only required brush to be burnt on the homesteads, robbing bees of their honey (which required smoke) and throwing down their cigarette without extinguishing the fire. Many cane-fields are burnt by this same kind of carelessness. Matches, smokers, and carelessness are too prevalent to prevent destruction by fire in these days. We should all act and preach caution.

WORMS.

Worms are one of the most destructive enemies the Hamakua forest has. I am undecided as to whether the fire or the worms destroyed the most of Hamakua forest the past ten years. If the past year's fire should be left out of the reckoning there would be no comparison, as but a few acres were destroyed by the fire, while the worms have destroyed hundreds of acres.

The Koas are the trees that are killed. These worms cannot be controlled by man, and the only way now to be seen, to counteract their destructive tendencies is to grow forest trees that have no such enemies.

STOCK.

All kinds of stock are believed to be injurious to forests at certain stages of its growth. This must be conceded, and that period is while the forest is young, but at its more advanced growth, it is believed, if stock were permitted its free range, it would do the forest more good than injury by partially at least, protecting it from fire. The fires that devasted so large a part of Hamakua's forest last year has proved an eye opener to all who are willing to look by looking they will see what was an old tangled forest two years ago, that stock never ranged. It is now burnt and dead. By looking further may be seen large strips of forest, old and young, where stock has ranged for generations and where fire was burning on their lower borders at the time of the big fire in Hamakua last year, but the brush, germs, weeds, grass, etc., had been eaten and tramped out of existence by the stock, so the fire made slow progress and was readily stopped, as there was but little to burn on top of the ground and the burning of the soil by digging ditches. Had it not been for the stock keeping the combustible material out of the way, these forests must have been destroyed, as was the forest above referred to where no stock ever were permitted to range. Fortunately by the assistance of the stock they were saved.

The excluding of stock from a reserved forest would menace its existence by exposing it to a destructive fire sooner or later, as the accumulations of combustible material in such a forest during a few decades of its growth would be a tinder box liable to be ignited by some careless hunter, smoker, or some other way during some dry windy time.

Such a forest fired under such favorable conditions for burning could not be saved, as human life would be in danger in front of such a fire, but a forest protected by stock even should a fire start it could readily be stopped without endangering life.

In conclusion, I suggest, that should our Government desire to experiment in forest growing in these Islands, instead of waiting generations for nature to plant and grow it for them, let the Government when it leases lands hereafter, require a certain number of acres of forest set, fenced and cared for each year. Trees set to be of some valuable, quick growing, long lived varieties.

Should this be done, a few years only could pass, ere we would have some promising forests that would do credit to the country and withal profitable and with but a small outlay of money. At the end of about three years, stock should be permitted to range such forest for its protection from fire by so doing the land could be used as a pasture while growing a valuable forest.

JNO. M. HORNER.

ENEMIES OF LANTANA.

The following report dealing with the importation of insects and other enemies of lantana cannot be considered more than a preliminary sketch of the subject, because the work itself is still far from being finished, and it must of necessity be a considerable time before the results of what has already been done can be ascertained. Naturally for much of the information contained herein, I have drawn upon the letters written to me by Prof. Koebele, with whom I have been in constant correspondence since the beginning of his work in Mexico, and to whom I have from time to time put many questions not only on matters of importance concerning the treatment of the material forwarded by him and its condition on arrival here, but also on matters of general interest, such as the effect of the insects on the lantana in Mexico, the abundance of the plant, the nature of the country where it grows best, and so on.

As is well known, two species of lantana were introduced into these Islands in 1858, one of which, the present pest, owing to the fact that its berries were greedily devoured by the imported mynah and the doves, quickly spread over a large extent of country, and still is spreading. The other, perhaps, because its berries are less palatable, remained practically as a cultivated plant.

I had hoped that in Mexico there might be some bird which would feed on the unripe berries and in this way get ahead of the dove and mynah, but there appears to be none.

It is quite clear that while the dove and mynah remain abundant and the lantana seeds freely as it now does, no destruction of the plant unless universal can ever check it. Even though many acres are cleared constant vigilance will be needed to destroy the young plants which spring from the seed carried from a adjoining lands and dropped by these birds. Both these birds take extremely long flights in ranging for food, passing from the coast to the uplands or vice versa in the course of the day. If however one can to a very large extent destroy the flowers or the berries before they ripen, one can very greatly check the rate at which the plant is spread, and then proceed to destroy the grown bushes, with some confidence that they will not be easily replaced by fresh seedlings.

As in these Islands, so in Mexico, the lantana camara, our common species, grows in very different localities. Thus in Orizaba it is comparatively wet, rain nearly every day in the wet season, and the lantana is rather soft and spongy and liable to the attack of fungoid diseases. There it grows along the path by rocky hill-sides and along well drained roads but is not numerous, often half a mile without a single plant. On a very steep rock hill it was found most numerously, a plant every fifty yards or so.

In the dry district of Morelos, it is found in the same scattered manner, a plant to about 500 yards, growing with other trees which are familiar here, the algaroba, and the gluebush (Acacia farnesiana). In a six mile walk along a river not a plant was found, but three other kinds of lantana were noticed rarely. In quite open grass land only three or four plants were found, and it was noticed that it was here eaten by the goats. In the best locality a plant was found every hundred yards in a half mile square, growing three or four feet high and generally the top nipped off by cattle.

In some ways unfortunately, the rain this year in Mexico was unusually late so that at the beginning of Mr. Koebele's work, from June onwards, the outlook was not very promising. On the 13th day of August, after rain had set in, he writes of Morelos, "the place has now become very interesting," (after 2 months' absence) "and I take more hopes." At the same time the information gathered as to the best localities for the lantana and the knowledge of the habits of some of the insects before the best season commenced was certainly well worth finding out in advance. In September seeing that Koebele had now acquired an extensive knowledge of the localities for lantana and had seen a good deal of the insects attacking it, I wrote to obtain his opinion as to whether it was certainly these that checked the plant, so far as he could ascertain. His answers of October 8th was, "Most positively the various insects keep the lantana in check in Mexico; no young plants are met with, it must be exceedingly rarely that these come up."

In a letter written October 14th, Mr. Koebele gives me a list of what he considered the most important insect enemies of lantana. This list consists of 23 different species, to which may be added two fungoid growths which attack the plant. These however by no means constitute the whole number of enemies, those which attack the foliage in general being entirely left out, since Mr. Koebele considers them of little importance. On this one point we are inclined to differ as it seems to me that some of these are likely to thrive especially well here, and few plants can stand repeated defoliation at certain seasons of the year. Nor does the list include those insects which we think will prove dangerous to the vegetation, nor even those of which we are suspicious and which require experimenting with before they can be released. Some of these in reality may eventually prove to be of great service.

Classifying the species included in the list according to their habits:

5 live to large extent on the seed, though sometimes eating buds, young shoots, etc.

10 chiefly feed on flowers and buds.
2 from galls on the flowers.
1 chiefly on growing shoots and flower buds.
2 are borers in the twigs.
1 is a large borer in the roots.
1 is a large borer in the lower parts of stem.
1 destroys or deforms the young leaves.

Some of these species I have yet to see and of a large proportion, I have so far only received very few individuals, far too few to lead me to expect that I have been successful in establishing them. This fact leads me to speak at some length of the difficulties inseparable from making introductions of this kind in a new and distant country, the more so as I find few people appreciate how great these really are. They are mainly due to three causes: (1) To the length of the journey from Mexico to these Islands and the climatic changes passed through on the way. (2) To the parasite enemies and diseases of the insects themselves. (3) That it is not easy to get required insects to breed when imported unless very large numbers are received.

On the first head it must be remembered (A) that the insects in Mexico are collected at an elevation of 4000 ft. and upwards and between the collecting ground and California have to pass through a very much hotter belt before they arrive at San Francisco and are put on ice for shipment here. In passing through this heat an enormous proportion of such species as have to be sent in their earlier stages, hatch out and die, at least in the hotter months. (B) It is extremely difficult to keep the food required on the journey in good condition, the flowers of the lantana being very delicate, and when shut up in quantities together all the parts of the plant readily go mouldly and the insects are destroyed. We have practically overcome this difficulty by the use of chemicals and special modes of packing.

(2) The lantana-eating insects are by themselves all subject to the attacks of parasites, and the attack is always fatal. In many of the species that would be most serviceable here the number that escape these parasites is extremely small. As an instance of this I may refer to a consignment of berries recently received. These berries were very badly attacked by two insects living internally in the seeds and entirely destroying these—one, the caterpillar of a small moth, the other the larva of a small fly. On the second day there emerged from the berries two individuals of the fly, not one of the moth but 45 parasites (of several different species) each one of the 45 being bred at the expense of one of the lantana-feeders. It is hardly necessary to say that the utmost care has to be taken that not one of these parasites is allowed to escape, since the efficiency of the work on the lantana by the various insects attacking it is enormously increased by the absence of parasites. It might be argued that as in Mexico the destroyers are efficient in spite of these parasites they would also be so here, but the cases are widely different. Here the lantana has had a start of over 40 years practically without enemies with much to favor its growth in soil and climate and latterly birds in great numbers to scatter the seed. In Mexico no doubt there is between the plant and its destroyers and between these and their parasites a state of equilibrium which might have been the case here had these been brought

with the plant. Now, however, a great multiplication of the lantana destroyers is necessary, and it is on the excessive increase which should take place in the lantana insects introduced without parasites which I should base the hope of success. What this increase can be, climate and other things being favorable, may be judged from that of the so-called lantana blight of Maui which is practically without enemies. It is very unlikely that more than a few individuals of this were accidentally imported on some fruit tree or ornamental tree or bush, and yet now countless myriads are found in a very limited area.

Besides the parasites some of the most efficient destroyers are subject to fungoid diseases. This is especially the case with a large borer—grub living in the stem, and a caterpillar which not only bores into the stems and roots, but comes out at night and eats complete grooves round the former. In one consignment of stems and roots I estimated that over a hundred of these two destroyers were sent but only two or three were alive on arrival. The others were simply converted into a mass of the parasitic fungus, and those still alive died within a day or two of the same disease. If one or two in the consignment are diseased some of the myriads of spores produced are sure to reach the others and infect them.

Two of the species, at least, that are subject to this disease are of great importance and their introduction should be attempted again and again till successful. How few of the larvae escape disease may be judged from the fact that neither Koebele in Mexico nor myself here have been able so far to breed the perfect insect. That these species survive at all is probably due to their being extremely prolific, and for this reason, if exempt from disease here, they should be very efficacious.

(3) Many of the most important destroyers of the lantana have so far been received only in very small numbers (largely owing to the extent to which they are parasitized) and at the same time they will not lay their eggs nor even pair in confinement. Owing to the presence in the Islands of the scale-bug known as the lantana blight, I find that there is a general impression that the Mexican insects are of the same sluggish character requiring to be spread by hand to be effective. On the contrary some of these are extrordinary active, and an individual liberated here in the morning, might easily be at the other end of the island by mid-day. If well established this certainly will greatly facilitate the spread of such species, but when one has only two or three individuals to turn out which starts off in different directions one cannot overlook the possibility that they may never meet again, to effect a pairing. Had the nature of the habits of many of these important insects been known beforehand, I believe that by making preparations for their reception on a large scale they

could have been induced to breed in captivity, but they certainly will not do so, when enclosed over a single growing bush in the open.

As to the final success of the work of importing lantana enemies personally I should not at present care to express a decided opinion. The experiment is, so far as I know, absolutely unique, nothing of a similar kind having been attempted in other countries. I can only say that Mr. Koebele believes that he will succeed, provided that he is allowed his own time. I have all along estimated the time necessary for the work to be longer than he has, though latterly I find he inclines to my view. The best season in Mexico is comparatively short, and I think it unlikely that we shall get all the destroyers already known to us imported before this ends. Moreover there is a lantana country south as yet uninvited, where there may be a large number of other destroyers. I have made no attempt to estimate the amount spent in recent years on clearing land of lantana, but I imagine it to be so large as to make the cost of the present experiment insignificant even if Mr. Koebele is given all the time he wants for further researches. Collecting in the hot country in Mexico is (as I myself have experienced) extremely laborious, and I have at times feared that he might find it necessary to give up, or be unable to return there, if this is desirable. This would be a matter for much regret as his knowledge is now invaluable and it would no doubt take another man more than a season's work to arrive at this.

As to the species that have already been turned loose in greater or less numbers, none of these so far as possibly can be foreseen, are likely to do damage to plants other than lantana. One or two which might have been established have been discarded at least temporarily, from perhaps an excess of caution. Many excellent enemies of lantana in Mexico are of course out of the question, since they would certainly damage other plants.

Incidentally in bringing the things over here to eliminate parasites, many interesting facts were observed. Thus the parasites of some seed-eating species would do excellent service in the forests here, where the seeds are much damaged by introduced insects. Similarly various other parasites were bred which might greatly reduce the Kou worm and that of the cocoanut, as well as the one now so injurious to citrus and other trees and the caterpillars of the Koa trees. Some time ago, Mr. Koebele wrote to me to do as I liked about introducing these parasites, but in no case have I done so, as there is no doubt that some of the best lantana destroyers would thereby lose some 90 per cent of their effectiveness and I think that these should be given every chance for some time to come. I may say that Mr. Koebele in his latest letter has fully approved of the course taken by me in this matter.

PROF. R. C. L. PERKINS.

AIEA, OAHU, H. T., Oct. 13, 1902.

MR. GEO. EWART,
Honolulu.

DEAR SIR:—You are named once more as a member of the committee on handling and transportation of cane. Will you undertake to write something on this subject, and if so, will you kindly address it to the Secretary of the Association, W. O. Smith, as I am called away to San Francisco on business matters and may not be back in time for the annual meeting.

Respectfully yours,

JAMES A. LOW.

2019 NUUANU AVE., HONOLULU, OAHU, NOV. 11TH, 1902.

W. O. SMITH, ESQ.,
Secretary Hawaiian Sugar Planters' Association,
Honolulu.

DEAR SIR:—Mr. Low, chairman of the committee, on "Handling and Transportation of Cane," having been called away to the Coast on business asked me to take his place, which I have done to the extent of the enclosed letters. I am now called away to Hawaii and am afraid I shall not get back in time to do any more than this. I may state that our work at Kilauea was very much the same at last year, only we paid 18 cts. per ton for plant cane and 20 cts. for rattoons. Our great trouble was the men lying off so much about the first of the month and pay week.

Yours truly,

G. W. R. EWART.

Mr. J. T. Moir, of Onomea Plantation sends no report, but a few notes:

On this plantation and on all others of this district (except Waiakea), the cane is carried to the mills by the "Fluming System."

The cane is cut and tied up in bundles of from 60 to 80 lbs. each and packed by the cutters, generally, a distance of from 100 to 150 feet and piled at the flume, and any odd corners or awkward places outside that distance are hauled to the flume by means of carts, sledges and pack animals as the case may be, but principally by sledges as they are easier handled in loading and unloading. We have to do considerable piling at flume, for night work.

There are on this plantation about 25 miles of stationary flume, with about 13 miles of portable flume, which is moved around as the case may require.

We use 1″x14″ lumber made up into 12′ foot long flume boxes for portable flumes, so that in moving a flume across a field, one man can pack one box readily. We are well supplied with water for fluming purposes, being very rarely short.

The greatest distance we have to flume cane to the mill is about 7 miles, the mill being situated a little to one side of the plantation.

The cost of cutting, bundling, packing, loading and transporting cane to mill is approximately .80c. per ton of cane.

Cutting:—Means cutting the cane and bundling it.

Loading:—Means labor in loading sledges, carts, pack animals, the use of animals and the piling of the cane at the flume.

Transporting Cane to Mill:—Means, labor in moving, placing, and building portable flumes, dropping the cane into the flume, guarding and superintending the flume while the cane is in transit to the mill, and use of animals in connection with same.

We had no contracts for cutting or loading cane, the work being all done by our regular day labor.

Very respectfully yours,

JOHN T. MOIR,
Manager Onomea Sugar Co.

PAPAALOA, OCT. 31ST, 1902.

MR. G. R. EWART,
Honolulu.

DEAR SIR:—I have yours of 20th. I don't know that I have anything instructive to say on the handling and transporting of sugar cane. We flume practically all our cane here, but we have not data of accuracy enough to make a reliable report. We have used the "Horner" gravity wire rope somewhat and found it to work very well under favorable conditions. We feel that we are justified in going to quite a heavy expense to secure water for transportation purposes.

Yours truly,

C. MCLENNAN.

HILO, HAWAII, OCT. 24, 1902.

GEO. R. EWART, ESQ.

DEAR SIR:—Your letter to hand and noted. In regard to our machines for loading and unloading canes, I am so sorry you did not write to me a week earlier, as I made out my report to James Scott of Kihei who is chairman on machinery, as he asked me to furnish him with what I could on machinery, I did so, still I think now it would have come under your head better. Our machines are a grand success saving about 30 men a day. I remain,

Yours faithfully,

C. C. KENNEDY.

The following is a list of the committees which were appointed for the year ending November, 1903:

Labor:—J. P. Cooke, Chairman; H. A. Isenberg, T. C. Davies, W. M. Giffard, E. F. Bishop, E. D. Tenney.

Cultivation:—James Gibb, Chairman; Aug. Ahrens, C. M. Walton, C. B. Wells.

Fertilization:—C. F. Eckart, Chairman; J. A. Scott, A. Lidgate, H. A. Baldwin, William Pullar.

Handling and Transportation of Cane:—Jas. Low, Chairman; C. McLennan, J. T. Moir, Geo. Ewart, E. E. Olding.

Manufacture:—W. W. Goodale, Chairman; F. B. McStocker, E. K. Bull, Jas. Renton, C. C. Kennedy.

Machinery:—Jas. Scott, Chairman; Geo. F. Renton, Jno. Watt, Hy. Deacon, D. Forbes.

Diseases of Cane:—Prof. Koebele, Chairman; W. G. Walker, F. Weber, Andrew Adams, L. Barckhausen.

Forestry:—D. Forbes, Chairman; Geo. C. Hewitt, J. M. Horner, Geo. N. Wilcox, H. P. Baldwin.

Experiment Station:—F. A. Schaefer, Chairman; F. M. Swanzy, E. E. Paxton, W. M. Giffard.

IRRIGATION.

Nowhere else in the world has irrigation been prosecuted with greater vigor or success than on the plantation properties of the Island of Hawaii in the past ten years. What was formerly arid and unproductive soil covered by wild brush and pasturing a few cattle, has, by the application of water at a large expenditure of money and enterprise, been converted into productive cane land more fertile than the finest orchards of the Mainland.

Each individual cane planter has been so absorbed, however, in creating properties by finding water for irrigation and by other pressing duties, that little time was devoted to studying the economic distribution of water and, with the object of developing some ideas on this line, the planters have invited the author of this paper to volunteer some suggestions on this subject.

ANCIENT IRRIGATION.

The many old ditches "Auwais" leading from the different water courses on the Islands, and covering the various kuleanas and taro patches show that irrigation was extensively practiced in olden times when the Islands had five times the present number of inhabitants.

The water leads were nearly all ditches excavated in the surface earth and repaired by the joint users, each of whom had to devote so many days towards maintenance. The water was also distributed between its users by set rules and at stated times, each district with its branch supply ditch getting so many hours flow of the stream.

As the streams were so numerous and the wants of the natives so easily satisfied, we can find the remains of no ambitious works of construction in the old irrigation system. We read, however, that Kamehameha I in 1780 during one of the rare epochs of peace which then prevailed, lead water by means of a tunnel at Niulii in the Kohala district of Hawaii. This great warrior, like the founder of his country in the Mainland, George Washington, was in civil life, therefore, an engineer of no mean ability.

MODERN IRRIGATION.

The present water supply of the Islands is derived from two sources: (1) By gravity from the natural flowing streams, the impounding of flood waters of same, and the interception of ground water by tunnelling; and (2) ground and artesian water from wells which is lifted from near sea level by means of pumping engines actuated by steam with either coal or oil for fuel or by electricity to the different levels irrigated.

The pioneers in long distance ditch building were: Claus Spreckels, H. P. Baldwin and Sam. T. Alexander. The former financed the H. C. & S. Co.'s ditch in 1879 which intercepted the streams on the northern slope of Haleakala on Maui from Honomauu westward and conveys them by means of ditches about thirty miles long with a capacity of fifty millions gallons daily, delivering the water to the plantation at an elevation of 250 feet above the sea. Mr. H. F. A. Schussler of San Francisco was the engineer of this project and the work was chiefly remarkable for the great lengths of forty inch syphon pipe used in crossing the ravines, and for the steep gradient employed in conveying the water.

In the last two years this ditch was intercepted at Kailua by a new ditch run on a grade of four feet per mile, twenty-two miles long, which delivers water at 450 foot elevation, thus obviating the expense of pumping to the higher level. Both ditches are used in flood periods to their full capacity, and it is contemplated to increase their utility by building, in the future, more feeder reservoirs to impound flood waters at suitable sites and deliver same into ditches at low water periods.

Messrs. Baldwin & Alexander built the Hamakua ditch, twenty miles long, parallel with and above, the Spreckels' ditch terminating at an altitude of nine hundred feet.

No accurate measurements have been made showing the loss from seepage in these ditches, which is to be regretted, but rough measurement made last year showed a forty per cent loss in the Hamakua ditch. Since then numerous ditches have been built on Maui, Oahu and Kauai for irrigation, the most notable of which is the Hanapepe ditch and syphon pipe built in Kauai to take out the Hanapepe river on the Makaweli Plantation, under the direction of the late Mr. Perry, C. E.

This work embraced 7040 feet of forty inch rivetted steel pipe, 1013 feet of tunnels, 14,618 feet of flume, five feet wide by forty inches deep, and ten miles of ditching on a general grade of seven feet per mile. This ditch has a capacity of thirty-five millions of gallons in 24 hours and was completed in 1890 at a cost of $250,000. The headworks of the Makaweli ditch in the canon of that name, now under construction under my supervision, on the same property involves 29 tunnels of a continuous length of five miles, seven feet wide and seven feet high excavated in the solid rock and built on a grade of eight feet per mile, which will give a daily capacity of over sixty millions of gallons when running four feet deep.

There is no flume or perishable material in this work and the character of its construction will keep the cost of maintenance down to a low point. It will deliver water on the plantation at an elevation of thirteen hundred feet, whence a fall of 225 feet will be made and used for power purposes, after which it will be distributed through the cane fields up to an altitude of 1075 feet.

This stream is extraordinarily steady in its flow, as its watershed is very precipitous, well wooded and inaccessible to animals and geographically so situated with regard to the Island of Kauai as to tap the heaviest rainfall, like the Waihee stream on Maui.

Many streams have been diverted and reservoirs made during the last five years on the Wailuku and Pioneer Plantations on Maui, the Oahu and Waialua Plantations on Oahu, and the Koloa, Makee and McBryde Plantations on Kauai. Practically no stream diversion for irrigation has been made on the largest Island, Hawaii, except the development of water for cane fluming purposes on Olaa, Pahala and Hutchinson Plantations. In fact no flowing surface streams exist on Hawaii for along 200 miles of coast from Kohala southerly around to Hilo. The country is of so porous a nature and so modern in formation, geologically speaking, that it passes the rainfall through like cinders and allows no surface accumulation of water. Having active volcanoes now smoldering, it does not require a prophet to announce that Hawaii is the most modern of the Island group. Many of the recent lava flows are quite distinct and comprise two varieties of lava, the "Pahoehoe" which is heavy and compact, having sometimes a smooth undulating surface, and the "Aa" which is much lighter in specific gravity than the former, floating on its surface during flows and broken up into all kinds of disintegrated masses on cooling.

RAINFALL.

The rainfall of the "Islands" is very peculiar in distribution. The windward-north-easterly-sides get a heavy rainfall varying from 60 to 200 inches a year, while the lee sides get in some places as light as 10 to 15 inches.

The rugged character of the mountain chains, as well as the forest growth, have important bearing on precipitation. The folly of wasteful forest destruction is now pretty well understood, and by none better than the Kohala and Hamakua districts of Hawaii, where the intense surface fires of last year gave a costly practical lesson to some of the most wilful offenders in this respect.

It should be in order for your local government to take the question of forest preservation vigorously in hand, as it is expecting too much from the Washington Federal authorities to devote much attention to what is purely a local subject. Nothing but good intentions have been expressed, so far, by members of this Association on forest preservation and, in my opinion, they should be followed up with good strenuous action to obtain any practical results.

Both streams and artesian waters are fed by mountain rainfalls. No water in the underground supplies filters from the sea or makes long distance sub-marine transit from the Mainland sources as some theories suggest.

The artesian supply of Oahu is perhaps the most peculiar and most generous that we find in any country, yielding from a small area 250 to 300 millions of gallons daily without any apparent diminution in the source, which is porous strata at a depth of from 400 to 800 feet below the sea level. The static level of the water in the wells penetrating this formation rises to an elevation of 40 feet above the sea level at Honolulu, and 22 feet at Ewa 16 miles westerly.

The intimate connection between the mountain water supply and the wells is proven by the discoloration of the water in the latter some hours after heavy freshets—due to rainfall occurring in the mountains.

The depth to which it is safe to lower the static surface level by pumping has been tested on each plantation. The rapid rise in salt by excessive pumping and lowering of the water level acts as a brake to all prudent managers in this respect. The Oahu artesian waters carry eight to twenty grains of salt per gallon while sixty grain water grows productive cane. It is a great mistake, however, to concentrate the pumping stations and draw too much water from a small area, as there is a liability to open seams and draw sea water into the wells if the surface of the fresh water is lowered too much. The pioneer in artesian water development was the late James Campbell who bored the first successful well at Honouliuli, Ewa, in 1879.

DUTY AND DISTRIBUTION OF WATER.

So much attention has been given to finding water and equipping new plantations that little time has been devoted to considering its economic distribution. A general "rule of thumb" unit of one million gallons of water for each 100 acres of cane cultivated has been accepted as the amount necessary to grow good cane. This quantity, if applied uniformly to the whole surface, would make a depth of 134 inches in one year excluding rainfall and evaporation which is possibly 50 inches in most of the irrigated properties. It means the application, for a crop period of one year and a half, of 22,800 tons of water per acre to produce 50 to 80 tons of cane, which to the lay mind, would appear to be excessive.

It is safe to say that leaky reservoirs, ditches, and unequal distribution prevent the application of not more than one-third the above quantity of the water to the roots of the cane "where it would do the most good."

The loss of gravity water is bad enough, but the loss of water pumped to an elevation at a heavy expense for fuel and pumping machinery is so serious a matter that it should be stopped. To pump 10,000,000 gallons daily against a head of 300 feet, with the ordinary pumps and fuel in service, will consume fifteen tons of coal daily which at $8.00 per ton amounts to $120.00 for daily fuel expenses.

Suppose this water travels along three miles of ditch which is not tight through which one-third of the water is lost through seepage, a daily loss (excluding interest and depreciation on the original pump plant) of $40.00 in money is made, besides the diminished supply of water for the crop. In 200 days this figures up to $8,000 and in six years incurs a loss of at least $50,000. How much better it is, therefore, to put $10,000 more into a ditch or first class flume as an original investment than to incur this constant loss. In how many plantations with pumping plants are proper steps taken to measure seepage losses and to take measures to stop them? One plantation manager in 1899 told me he objected to weirs for measuring water, because unlike fertilizers, "they did not grow any more cane."

One new ditch 6 miles long which I personally measured in 1900 carried 3,965,565 gallons at the head and 2,241,000 gallons at the end showed a loss of 1,724,565 gallons in transit, of 43 5-10%. Two more old ditches measured in Maui this past summer show losses of 40%, one in twelve miles though good formation and the other in four miles through sandy or porous soil. In India where irrigation has been practiced for years and water procured from gravity supplies, the same losses have been experienced. In the United States careful measurements have been made in all irrigating canals during the past two years and similar losses have been discovered in unlined ditches with one exception, the Gage canal at Riverside.

This ditch is 20 miles long, five to ten feet wide in the bottom, and four feet deep and it has been lined throughout with ¾ inch thickness of cement. In that distance with a capacity of 50,000,000 gallons daily there is a seepage loss of only one per cent. What can be accomplished in California for inexpensive gravity water can surely be done here for costly pumped water. The low price of sugar and the restricted labor conditions should be sufficient incentive to stop all such leaks on plantation properties.

I hear on all sides objections to flumes for conveying water, because they rot and have to be renewed in six or eight years. If ditches cannot be made tight, it is greater economy to build good flumes and renew them when necessary than allow pumped water to escape in leaky and porous ditches. A three foot diameter semi-circular galvanized iron flume laid on a grade of ten feet per mile delivers without loss 10,000,000 gallons daily on the Pioneer Plantation on Maui on porous ground.

MEASUREMENT OF WATER.

This is a matter which every irrigated property owner should carefully make. Well constructed weirs with bevelled edges form the most accurate medium if properly placed. Measuring instruments can be purchased from instrument makers such as Leitz or Sala of San Francisco which are self recording and sheets can be taken off weekly which will show the depth of water at each hour during that period.

The weirs may vary in width according to the size of the ditch and quantity of water conveyed.

In the accompanying table I have computed the discharge for the flow over a five foot weir carrying up to 10,330,000 gallons in twenty-four hours. Similar tables may be computed for any particular width of weir, though it is well, if practicable, to have them an even number of feet in width.

TABLE OF DISCHARGES UNDER DIFFERENT HEADS OVER A FIVE FOOT WEIR, WITH TWO END CONTRACTIONS COMPUTED FROM FRANCIS'S FORMULAE $Q=3.33\ (L.-.2H)\ H^{\frac{3}{2}}$ BY M. M. O'SHAUGHNESSY, C. E.

Depth of Water on Crest		Discharge		Depth of Water on Crest		Discharge	
Feet	Inches	Cubic feet per Second	Gallons 24 Hours	Feet	Inches	Cubic feet per Second	Gallons 24 Hours
.02	¼	.047	30,375	.52	6¼	6,114	3,951,307
.04	½	.133	85,954	.54	6½	6,464	4,177,502
06	¾	.244	157,690	.56	6¾	6,821	4,408,221
.08	1	.376	242,998	.58	7	7,184	4,642,818
.10	1¼	.524	338,646	.60	7¼	7,553	4,881,292
.12	1½	689	445,281	.62	7½	8,116	5,245,144
.15	1¾	.962	621,713	.65	7¾	8,499	5,492,666
.17	2	1.159	749,029	.67	8	8,887	5,743,418
.19	2¼	1.369	884,746	.69	8¼	9,280	5,997,403
.21	2½	1.589	1,026,926	.71	8½	9,678	6,254,620
.23	2¾	1.820	1,176,215	.73	8¾	10,082	6,515,714
.25	3	2.060	1,331,320	.75	9	10,490	6,779,393
.27	3¼	2.311	1,493,534	.77	9¼	10,903	7,046,303
.29	3½	2.570	1,660,919	.79	9½	11,322	7,317,092
.31	3¾	2.838	1,834,120	.81	9¾	11,745	7,590,464
.33	4	3.115	2,013,137	.83	10	12,172	7,866,423
.35	4¼	3 399	2,196,678	.85	10¼	12,604	8,145,612
.37	4½	3.692	2,386,036	.87	10½	13,041	8,428,033
.39	4¾	3.992	2,579,918	.89	10¾	13,482	8,713,039
.42	5	4.456	2,879,788	.92	11	14,152	9,146,041
.44	5¼	4.774	8,085,302	.94	11¼	14,604	9,438,156
.46	5½	5.099	3,295,341	.96	11½	15,060	9,732,856
.48	5¾	5.431	3,509,903	.98	11¾	15,520	10,030,141
50	6	5.769	3,728,343	1.00	12	15,984	10,330,012

Sometimes head enough cannot be procured for suitable weir conditions and then it is advisable to use measuring flumes.

Flumes for this purpose should be 12 feet long or double the width of the ditch at least. The bottom should be horizontal and the sides vertical.

The channel of the ditch should be uniform in grade and section for 100 feet above the flumes.

An automatic register float can be employed as for weirs in keeping a record of the depth of water flowing at different hours through the flume. By gauging the velocity, the discharge for different depths can be computed; or by placing similar flumes at different points, the comparative loss of water will show at once without any computation. There is a practicable limit to the refinement which can be used in saving water on ordinary plantations, especially in the distributing systems through the cane fields, but more flumes of iron and wood, and better ditches I have shown to be a necessity.

Considering, however, the extent of construction work accomplished on so many new plantations during the past five years and under such rushed and difficult conditions, it is gratifying that so much of it is so well done and reflects credit on the managements in charge.

RESERVOIRS.

I cannot conclude this subject without referring to the necessity of building good reservoirs wherever tight and economic sites exist. The cost of making embankment, the capacity of pond, its freedom from leakage and the number of times it can be filled yearly, are all elements to consider before investing in a reservoir to hold freshet or surplus waters. No night irrigation fed from pumped water should be practiced. It is always prudent to have connected with each pump, a distributing reservoir of at least a size to hold a day's run of the pump. This should be tight, and some very good examples of successful ones paved with stone and grouted with cement, have been built during the last year at the Pioneer Plantation, Lahaina.

All earthen dams should be built up in layers one foot thick, thoroughly tamped, wetted and rolled. The inner slopes should be flat at least 2½ to 1 and paved with stone, and ample stone paved wasteways should be made through the original formation away from the dam to allow freshets to escape. There is a risk in building any dams over 50 feet high in this country, as the subsoil and formation are so porous and uncertain, that water under a high pressure is liable to find some underground rent or lava duct and escape. Careful examination of the surrounding strata should always be made before undertaking any extensive scheme of dam construction.

M. M. O'Shaughnessy, C. E.,
M. Am. Coc. C. E's.

10 HAWAIIAN SUGAR CROPS, 1893-1902. FROM OCTOBER 1, 1892, TO SEPTEMBER 3

HAWAII—	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
Waiakea Mill Co.	3,836	6,416	5,028	6,410	8,239	7,763	9,191	9,226	10,800	8,700
Hilo Portuguese Sugar Mill Co.	....	....	....	105	661	260	932	967	....	....
Hawaii Mill Co.	....	....	....	....	....	....	....	....	843	985
Hilo Sugar Co.	6,044	8,468	5.514	7,216	6,744	8,390	6,880	7,841	10,214	9,255
Onomea Sugar Co.	6,883	9,400	5,907	10,013	10,432	8,904	8,404	7,131	8,722	11,880
Pepeekeo Sugar Co.	4,773	5,709	4,097	6,502	7,474	6,914	7,350	6,207	7,173	6,627
Honomu Sugar Co.	2,485	3,534	2,895	3,844	5,181	4,932	4,968	5,328	4,401	6,235
Hakalau Plantation Co.	5,327	5,234	4,115	7,675	9,461	9,218	8,980	11,931	10,932	11,700
Laupahoehoe Sugar Co.	1,410	....	1,354	2,430	6,032	3,971	5,337	4,119	5,504	7,909
Ookala Sugar Co.	1,562	1,575	835	3,261	2,583	3,555	3,564	3,302	4,968	1,157
Kukaiau Plantation Co.	377	600	766	890	1,817	1,170	1,748	1,525	2,000	1,118
Kukaiau Mill Co.	377	610	800	890	1,818	1,170	1,732	1,530	2,000	1,118
Hamakua Mill Co.	2,550	3,431	3,583	7,330	9,050	4,133	6,081	6,078	7,808	2,105
Paauhau Plantation Co.	3,008	4,500	5,343	10,957	10,135	3,509	7,529	7,629	9,635	1,322
Honokaa Sugar Co.	1,528	2,567	2,905	6,774	10,018	6,198	9,111	8,117	9,903	3,089
R. M. Overend	290	467	....	....	....	....	....	....	....	....
Pacific Sugar Mill	1,894	2,620	2,931	5,885	6,700	3,327	4,650	4,774	4,948	2,517
Niulii Mill and Plantation	701	1,000	629	1,468	2,317	1,349	2,226	1,805	1,516	1,146
Halawa Plantation	700	1,039	687	1,198	1,406	800	1,049	1,571	1,357	575
Kohala Sugar Co.	2,203	2,543	2,510	3,778	4,903	1,508	4,119	3,345	3,160	1,096
Puehuehu Plantation	974	803	831	1,256	1,007	....	....	....	....	....
Union Mill Co.	844	803	997	1,230	994	1,068	1,668	2,265	2,003	463
Hawi Mill (R. R. Hind)	1,230	1,470	1,604	2,775	1,823	877	1,222	2,277	2,727	1,373
Beecroft Plantation	754	765	863	1,043	1,485	426	609	632	325	....
Kona Sugar Co.	....	....	....	....	....	....	....	285	1,500	1,391
Hutchinson Sugar Plantation Co.	3,255	4,040	5,709	9,179	7,544	7,104	7,732	8,338	9,928	8,021
Hawaiian Agricultural Co.	3,796	4,440	1,608	6,660	8,553	4,795	11,318	9,001	10,956	11,998
L. C. Chong—Pahala	277	165	132	530	359	265	839	....	....	....
Puakea	....	....	....	....	....	....	....	....	145	307
Olaa Sugar Co.	....	....	....	....	....	....	....	....	1,150	16,748
Puna Sugar Co.	....	....	....	....	....	....	....	....	....	2,460
	57,078	72,199	61,643	109,299	126,736	91,606	117,239	115,224	134,618	121,295

10 HAWAIIAN SUGAR CROPS. 1893 1902. FROM OCTOBER 1, 1892, TO SEPTEMBER 30, 1902.—Continued.

MAUI—	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
Kipahulu Sugar Co	1,639	1,912	976	1,787	2,047	2,250	1,931	1,890	1,992	1,427
Hamoa Plantation	945	868	1,119	1,378	852	1,411	2,026	2,114	1,450	1,748
Hana Plantation Co	2,154	2,596	2,492	2,771	2,350	2,141	3,175	3,406	2,774	2,700
Haiku Sugar Co	4,289	3,581	3,688	4,986	5,400	4,648	4,865	5,512	5,488	4,234
Paia Plantation	5,512	5,456	4,880	5,606	6,376	5,801	6,268	6,795	7,216	4,146
Hawaiian Commercial & Sugar Co	11,106	11,429	6,788	11,933	12,537	15,072	16,621	17,858	22,345	19,477
Waihee Sugar Co	1,369	1,810	....	....	....	....	....	....	....	....
Wailuku Sugar Co	2,117	1,762	4,900	5,655	6,461	6,725	7,412	7,976	7,902	5,934
Waikapu Sugar Co	534	786	....	....	....	....	....	....	....	....
Olowalu Co.	702	937	905	1,163	1,112	1,425	1,502	1,480	1,240	1,055
Pioneer Mill Co., Ltd	2,303	2,558	1,987	3,818	3,912	5,560	10,589	10,316	6,568	9,960
Kihei Plantation Co	....	....	....	....	....	....	....	....	1,374	5,562
Maui Sugar Co	....	....	....	....	....	....	....	....	....	483
	32,670	33,686	27,735	39,097	41,047	45,033	54,389	57,347	58,349	56,726
OAHU—										
Waimanalo Sugar Co	1,560	1,650	1,600	3,370	2,230	3,004	2,352	2,932	3,045	2,985
Heeia Agricultural Co., Ltd	2,191	1,660	1,472	1,915	1,798	2,167	2,191	2,309	1,507	631
Laie Plantation	340	125	100	101	78	300	494	179	1,693	430
Kahuku Plantation Co	4,026	3,973	2,672	3,369	3,976	4,356	7,008	5,647	7,072	5,623
Waialua—Halstead Bros.	947	662	872	1,019	1,886	2,015	....	....	....	....
Waialua Agricultural Co	....	....	....	....	....	....	....	1,516	17,699	17,001
Waianae Co.	3,114	2,940	2,500	3,884	3,804	4,055	3,506	4,019	4,020	5,000
Ewa Plantation Co	7,686	7,833	8,217	12,124	15,157	18,284	22,334	21,573	33,036	38,775
Apokaa Sugar Co	....	....	....	....	....	....	....	....	....	901
Oahu Sugar Co	....	....	....	....	....	....	7,935	15,450	21,454	26,724
Honolulu Plantation	....	....	....	....	....	....	....	....	10,008	9,800
	19,864	18,843	17,433	25,782	28,929	34,181	45,820	53,625	99,534	107,870

10 HAWAIIAN SUGAR CROPS, 1893-1902. FROM OCTOBER 1, 1892, TO SEPTEMBER 30, 1902 Continued.

KAUAI—	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
Princeville Plantation Co	497	....	....	....	....	....	....	....	....	....
Kilauea Sugar Co	3,112	3,502	4,050	5,507	4,651	4,563	5,420	5,254	5,364	3,762
Makee Sugar Co	7,659	6,537	7,454	7,439	9,175	8,510	9,350	8,575	9,954	11,232
Hanamaulu Mill and A. S. Wilcox	3,752	3,445	1,997	2,386	2,550	3,194	3,962	....	....	....
Lihue Plantation Co	3,688	3,893	6,872	8,883	9,642	10,914	13,333	15,289	18,356	13,674
Grove Farm Plantation	2,333	1,762	1,141	1,632	1,513	1,355	1,751	1,962	2,183	2,915
Koloa Sugar Co	2,828	2,106	2,278	3,852	3,825	4,327	5,268	5,004	5,492	5,001
A. H. Smith & Co	....	364	162	675	176	469	....	....	....	....
Eleele Plantation	1,284	986	977	1,232	1,400	1,489	....	....	....	....
McBryde Sugar Co	....	....	....	....	....	....	1,491	1,790	2,208	9,113
Hawaiian Sugar Co	12,800	13,392	11,172	11,407	11,167	13,200	14,350	13,480	13,419	11,480
Gay & Robinson	1,300	1,052	1,509	1,508	1,510	1,600	1,821	2,001	1,554	2,265
Waimea Sugar Mill Co	733	822	509	1,183	1,050	1,026	1,021	976	919	565
Meier & Kruse	....	....	952	1,245	1,505	1,518	....	....	....	....
Kekaha Sugar Co	1,309	2,470	2,054	2,602	3,483	3,480	6,942	8,287	7,412	8,978
H. P. Faye & Co	1,714	1,373	1,102	1,357	1,824	1,961	....	....	....	....
V. Knudsen	....	....	587	742	943	988	650	730	676	735
Total	43,009	41,704	42,816	51,650	54,414	58,594	65,359	63,348	67,537	69,720

	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
HAWAII	57,078	72,199	61,643	109,299	126,736	91,606	117,239	115,224	134,618	121,295
MAUI	32,670	33,689	27,735	29,097	41,047	45,033	54,389	57,347	58,349	56,726
OAHU	19,864	18,843	17,433	35,782	28,929	34,181	45,820	53,625	99,534	107,870
KAUAI	43,009	41,704	42,816	51,650	54,414	58,594	65,359	63,348	67,537	69,720
Total	152,621	166,432	149,627	225,828	251,126	229,414	282,807	289,544	360,038	355,611

HAWAIIAN SUGAR PLANTERS' ASSOCIATION,

By its Secretary,

WILLIAM O. SMITH.

Honolulu, November 1, 1902.

STATEMENT OF HAWAIIAN SUGAR CROP. 1901-1902.

From Oct. 1, 1901, to Sept. 30, 1902.

ISLANDS.	Tons.	Total Tons.
HAWAII.		
Hawaii Mill Co.	985	
Waiakea Mill Co.	8,700	
Hilo Sugar Co.	9,255	
Onomea Sugar Co.	11,880	
Pepeekeo Sugar Co.	6,627	
Honomu Sugar Co.	6,235	
Hakalau Plantation Co.	11,700	
Laupahoehoe Sugar Co.	7,909	
Ookala Sugar Co.	1,157	
Kukaiau Plantation Co.	1,118	
Kukaiau Mill Co.	1,118	
Hamakua Mill Co.	2,105	
Paauhau Plantation Co.	1,322	
Honokaa Sugar Co.	3,089	
Pacific Sugar Mill	2,517	
Niulii Mill and Plantation	1,146	
Halawa Plantation	575	
Kohala Sugar Co.	1,096	
Union Mill Co.	463	
Hawi Mill (R. R. Hind)	1,373	
Kona Sugar Co.	1,391	
Hutchinson Sugar Plantation Co.	8,021	
Hawaiian Agricultural Co.	11,998	
Puakea Plantation	307	
Olaa Sugar Co.	16,748	
Puna Sugar Co.	2,460	
		121,295
MAUI.		
Kipahulu Sugar Co.	1,427	
Hamoa Plantation	1,748	
Hana Plantation Co.	2,700	
Haiku Sugar Co.	4,234	
Paia Plantation	4,146	
Hawaiian Commercial & Sugar Co.	19,477	
Wailuku Sugar Co.	5,934	
Olowalu Co.	1,055	
Pioneer Mill Co., Ltd.	9,960	
Kihei Plantation Co., Ltd.	5,562	
Maui Sugar Co.	483	
		56,726
OAHU.		
Waimanalo Sugar Co.	2,985	
Heeia Agricultural Co., Ld.	631	
Laie Plantation Co.	430	
Kahuku Plantation Co.	5,623	
Waialua Agricultural Co.	17,001	
Waianae Co.	5,000	
Ewa Plantation Co.	38,775	
Oahu Sugar Co.	26,724	
Honolulu Plantation Co.	9,800	
Apokaa Sugar Co.	901	
		107,870
KAUAI.		
Kilauea Sugar Co.	3,762	
Makee Sugar Co.	11,232	
Lihue Plantation Co.	13,674	
Grove Farm Plantation	2,915	
Koloa Sugar Co.	5,001	
McBryde Sugar Co	9,113	
Hawaiian Sugar Co.	11,480	
Gay & Robinson	2,265	
Waimea Sugar Mill Co.	565	
Kekaha Sugar Co.	8,978	
Estate V. Knudsen	735	
		69,720
Total		355,611

AGENTS.	Tons.	Total Tons.
W. G. IRWIN & CO., LTD.		
Honolulu Plantation Co.	9,800	
Paauhau Plantation Co.	1,322	
Hutchinson Sugar Plantation Co.	8,021	
Hakalau Plantation Co.	11,700	
Hilo Sugar Co.	9,255	
Kilauea Sugar Co.	3,762	
Waimanalo Sugar Co.	2,985	
Olowalu Co.	1,055	
		47,900
H. HACKFELD & CO., LTD.		
Lihue Plantation Co.	13,674	
Grove Farm Plantation	2,915	
Koloa Sugar Co.	5,001	
Kekaha Sugar Co.	8,978	
Pioneer Mill Co.	9,960	
Kipahulu Sugar Co.	1,427	
Kukaiau Plantation Co.	1,118	
Oahu Sugar Co.	26,724	
Hawaii Mill Co., Ltd.	985	
		70,782
THEO. H. DAVIES & CO., LTD.		
Waiakea Sugar Co.	8,700	
Pepeekeo Sugar Co.	6,627	
Laupahoehoe Sugar Co.	7,909	
Kukaiau Mill Co.	1,118	
Hamakua Mill Co.	2,105	
Niulii Mill and Plantation	1,146	
Union Mill Co.	463	
McBryde Sugar Co.	9,113	
Puakea Plantation	307	
		37,488
C. BREWER & CO., LTD.		
Hawaiian Agricultural	11,998	
Wailuku Sugar Co.	5,934	
Honomu Sugar Co.	6,235	
Hamoa Plantation	1,748	
Onomea Sugar Co.	11,880	
Ookala Sugar Planta'n Co.	1,157	
		38,952

CASTLE & COOKE, LTD.

Waialua Agricultural Co..	17,001	
Ewa Plantation Co.	38,775	
Apokaa Sugar Co.	901	
Kohala Sugar Co.	1,096	
Waimea Sugar Mill Co. ..	565	
		58,338

ALEXANDER & BALDWIN, LTD.

Hawaiian Sugar Co.	11,480	
Paia Plantation	4,146	
Haiku Sugar Co.	4,234	
Hawaiian Commercial & Sugar Co.	19,477	
Kihei Plantation Co., Ltd.	5,562	
Kahuku Plantation Co. ...	5,623	
		50,522

F. A. SCHAEFER & CO.

Honokaa Sugar Co.	3,089	
Pacific Sugar Mill	2,517	
Maui Sugar Co.	483	
		6,089

M. S. GRINBAUM & CO., LTD.

Hana Plantation Co.		2,700

HENRY WATERHOUSE & CO.

Laie Plantation	430	
Gay & Robinson	2,265	
Halawa Plantation	575	
		3,270

B. F. DILLINGHAM CO., LTD.

Puna Sugar Co.	2,460	
Olaa Sugar Co.	16,748	
		19,208

MAKEE SUGAR CO.

Makee Sugar Co.	11,232

J. M. DOWSETT.

Waianae Co.	5,000

C. BOLTE.

Heeia Agricultural Co., Ld.	631

HIND, ROLPH & CO.

Hawi Mill (R. R. HIND).	1,373

H. M. VON HOLT.

Estate V. Knudsen	735

KONA SUGAR CO.

Kona Sugar Co.	1,391
Total	355,611

HAWAIIAN SUGAR PLANTERS, ASSOCIATION,

By its Secretary,

WILLIAM O. SMITH.

Honolulu, November 1, 1902.